

N-channel 1050 V, 1.4  $\Omega$  typ., 4 A MDmesh™ K5  
Power MOSFETs in TO-220, IPAK and TO-247 packages

Datasheet - production data

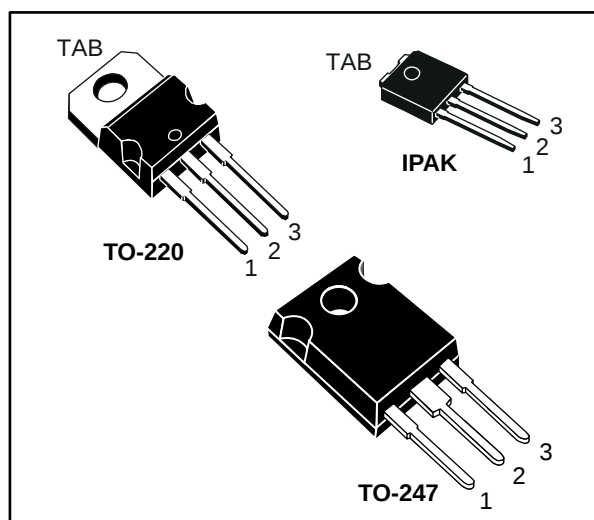
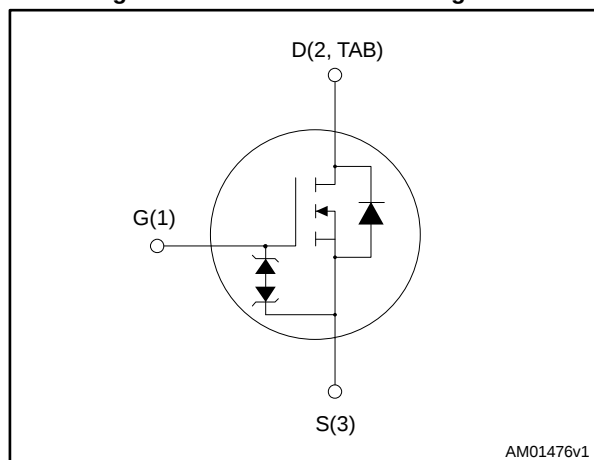


Figure 1: Internal schematic diagram



## Features

| Order code | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | P <sub>TOT</sub> |
|------------|-----------------|--------------------------|----------------|------------------|
| STP7N105K5 | 1050 V          | 2 $\Omega$               | 4 A            | 110 W            |
| STU7N105K5 |                 |                          |                |                  |
| STW7N105K5 |                 |                          |                |                  |

- Industry's lowest R<sub>DS(on)</sub> x area
- Industry's best FoM (figure of merit)
- Ultra-low gate charge
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

This very high voltage N-channel Power MOSFET is designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1: Device summary

| Order code | Marking | Package | Packaging |
|------------|---------|---------|-----------|
| STP7N105K5 | 7N105K5 | TO-220  | Tube      |
| STU7N105K5 |         | IPAK    |           |
| STW7N105K5 |         | TO-247  |           |

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol                         | Parameter                                                                                                                    | Value       | Unit |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------|------|
| V <sub>GS</sub>                | Gate- source voltage                                                                                                         | ± 30        | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                                         | 4           | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                                        | 3           | A    |
| I <sub>DM</sub> <sup>(1)</sup> | Drain current (pulsed)                                                                                                       | 16          | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                                  | 110         | W    |
| I <sub>AR</sub>                | Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>jmax</sub> )                                  | 1.5         | A    |
| E <sub>AS</sub>                | Single pulse avalanche energy<br>(starting T <sub>J</sub> = 25 °C, I <sub>D</sub> =I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 132         | mJ   |
| dv/dt <sup>(2)</sup>           | Peak diode recovery voltage slope                                                                                            | 4.5         | V/ns |
| dv/dt <sup>(3)</sup>           | MOSFET dv/dt ruggedness                                                                                                      | 50          | V/ns |
| T <sub>j</sub>                 | Operating junction temperature range                                                                                         | - 55 to 150 | °C   |
| T <sub>stg</sub>               | Storage temperature range                                                                                                    |             |      |

**Notes:**<sup>(1)</sup>Pulse width limited by safe operating area.<sup>(2)</sup>I<sub>SD</sub> ≤ 4 A, di/dt ≤ 100 A/μs, V<sub>DS(peak)</sub> ≤ V<sub>(BR)DSS</sub> ; V<sub>SD</sub> ≤ 840 V<sup>(3)</sup>V<sub>DS</sub> ≤ 840 V

Table 3: Thermal data

| Symbol                | Parameter                            | Value  |      |        | Unit |
|-----------------------|--------------------------------------|--------|------|--------|------|
|                       |                                      | TO-220 | IPAK | TO-247 |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max | 1.14   |      |        | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-amb max  | 62.5   | 100  | 50     | °C/W |

## 2 Electrical characteristics

(T<sub>CASE</sub> = 25 °C unless otherwise specified).

Table 4: On/off states

| Symbol               | Parameter                         | Test conditions                                                                       | Min. | Typ. | Max. | Unit |
|----------------------|-----------------------------------|---------------------------------------------------------------------------------------|------|------|------|------|
| V <sub>(BR)DSS</sub> | Drain-source breakdown voltage    | V <sub>GS</sub> = 0, I <sub>D</sub> = 1 mA                                            | 1050 |      |      | V    |
| I <sub>DSS</sub>     | Zero gate voltage drain current   | V <sub>GS</sub> = 0, V <sub>DS</sub> = 1050 V                                         |      |      | 1    | μA   |
|                      |                                   | V <sub>GS</sub> = 0, V <sub>DS</sub> = 1050 V, T <sub>C</sub> = 125 °C <sup>(1)</sup> |      |      | 50   | μA   |
| I <sub>GSS</sub>     | Gate body leakage current         | V <sub>DS</sub> = 0, V <sub>GS</sub> = ± 20 V                                         |      |      | ±10  | μA   |
| V <sub>GS(th)</sub>  | Gate threshold voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 100 μA                           | 3    | 4    | 5    | V    |
| R <sub>DS(on)</sub>  | Static drain-source on-resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 2 A                                          |      | 1.4  | 2    | Ω    |

**Notes:**

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

Table 5: Dynamic

| Symbol                            | Parameter                             | Test conditions                                         | Min. | Typ. | Max. | Unit |
|-----------------------------------|---------------------------------------|---------------------------------------------------------|------|------|------|------|
| C <sub>iss</sub>                  | Input capacitance                     | V <sub>DS</sub> = 100 V, f = 1 MHz, V <sub>GS</sub> = 0 | -    | 380  | -    | pF   |
| C <sub>oss</sub>                  | Output capacitance                    |                                                         | -    | 40   | -    | pF   |
| C <sub>rss</sub>                  | Reverse transfer capacitance          |                                                         | -    | 0.65 | -    | pF   |
| C <sub>o(tr)</sub> <sup>(1)</sup> | Equivalent capacitance time related   | V <sub>GS</sub> = 0, V <sub>DS</sub> = 0 to 840 V       | -    | 47   | -    | pF   |
| C <sub>o(er)</sub> <sup>(2)</sup> | Equivalent capacitance energy related |                                                         | -    | 17   | -    | pF   |
| R <sub>G</sub>                    | Intrinsic gate resistance             | f = 1 MHz open drain                                    | -    | 7    | -    | Ω    |
| Q <sub>g</sub>                    | Total gate charge                     | V <sub>DD</sub> = 840 V, I <sub>D</sub> = 4 A           | -    | 11   | -    | nC   |
| Q <sub>gs</sub>                   | Gate-source charge                    | V <sub>GS</sub> = 10 V                                  | -    | 2.8  | -    | nC   |
| Q <sub>gd</sub>                   | Gate-drain charge                     | Figure 18: "Test circuit for gate charge behavior"      | -    | 5.6  | -    | nC   |

**Notes:**

<sup>(1)</sup>Time related is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

<sup>(2)</sup>Energy related is defined as a constant equivalent capacitance giving the same stored energy as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

Table 6: Switching times

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                         | Min. | Typ. | Max. | Unit |
|--------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 525V$ , $I_D = 2A$ , $R_G = 4.7\Omega$ ,<br>$V_{GS} = 10V$<br>(see <a href="#">Figure 17: "Test circuit for resistive load switching times"</a> and<br><a href="#">Figure 22: "Switching time waveform"</a> ) | -    | 17.5 | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                         | -    | 7    | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                         | -    | 43   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                         | -    | 25   | -    | ns   |

Table 7: Source drain diode

| Symbol         | Parameter                     | Test conditions                                                                                                                                                                    | Min. | Typ. | Max. | Unit    |
|----------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------|
| $I_{SD}$       | Source-drain current          |                                                                                                                                                                                    | -    |      | 4    | A       |
| $I_{SDM}$      | Source-drain current (pulsed) |                                                                                                                                                                                    |      |      | 16   | A       |
| $V_{SD}^{(1)}$ | Forward on voltage            | $I_{SD} = 4A$ , $V_{GS} = 0$                                                                                                                                                       | -    |      | 1.6  | V       |
| $t_{rr}$       | Reverse recovery time         | $I_{SD} = 4A$ , $V_{DD} = 60V$<br>$di/dt = 100A/\mu s$ ,<br><a href="#">Figure 19: "Test circuit for inductive load switching and diode recovery times"</a>                        | -    | 370  |      | ns      |
| $Q_{rr}$       | Reverse recovery charge       |                                                                                                                                                                                    | -    | 3    |      | $\mu C$ |
| $I_{RRM}$      | Reverse recovery current      |                                                                                                                                                                                    | -    | 16.5 |      | A       |
| $t_{rr}$       | Reverse recovery time         | $I_{SD} = 4A$ , $V_{DD} = 60V$<br>$di/dt = 100A/\mu s$ ,<br>$T_j = 150^\circ C$<br><a href="#">Figure 19: "Test circuit for inductive load switching and diode recovery times"</a> | -    | 600  |      | ns      |
| $Q_{rr}$       | Reverse recovery charge       |                                                                                                                                                                                    | -    | 4.4  |      | $\mu C$ |
| $I_{RRM}$      | Reverse recovery current      |                                                                                                                                                                                    | -    | 14.5 |      | A       |

**Notes:**

<sup>(1)</sup>Pulsed: pulse duration = 300 $\mu s$ , duty cycle 1.5%

Table 8: Gate-source Zener diode

| Symbol        | Parameter                     | Test conditions                | Min | Typ. | Max. | Unit |
|---------------|-------------------------------|--------------------------------|-----|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1mA$ , $I_D = 0$ | 30  | -    | -    | V    |

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics (curves)

Figure 2: Safe operating area for TO-220 and TO-247

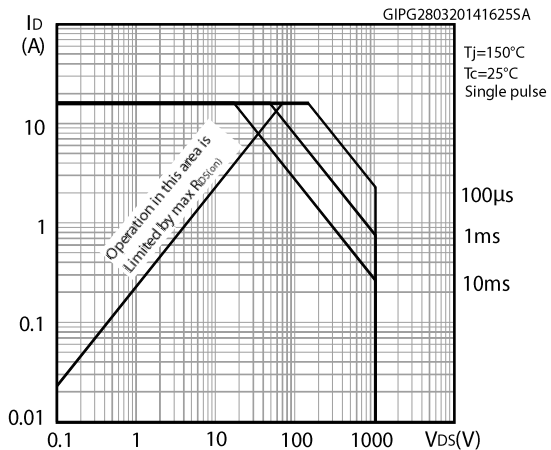


Figure 3: Thermal impedance for TO-220 and TO-247

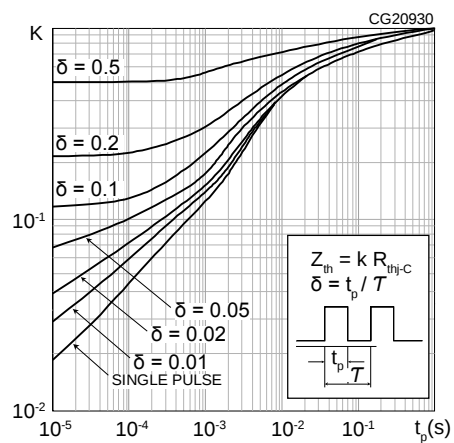


Figure 4: Safe operating area for IPAK

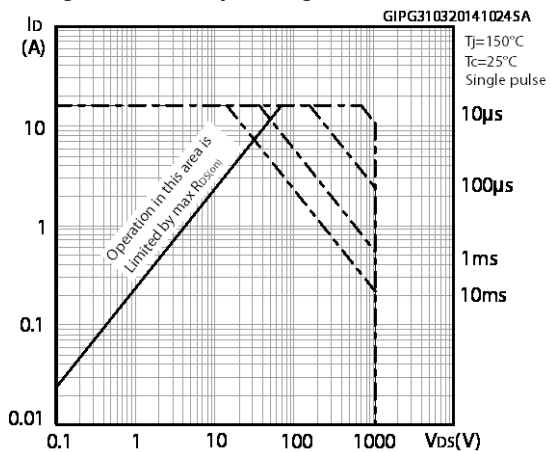


Figure 5: Thermal impedance for IPAK

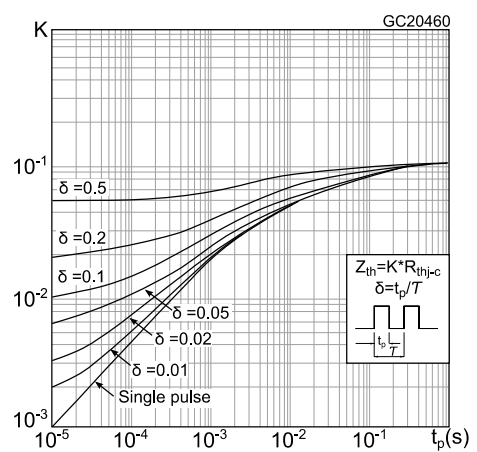


Figure 6: Output characteristics

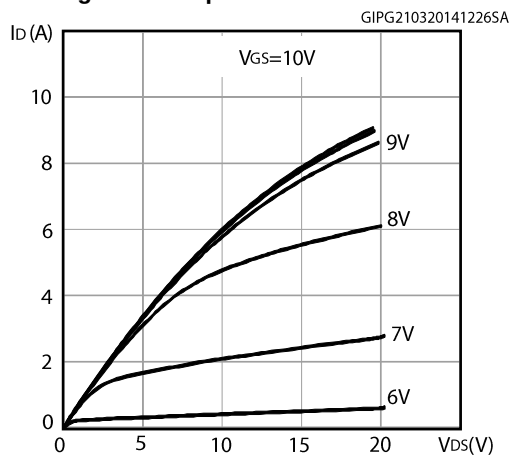


Figure 7: Transfer characteristics

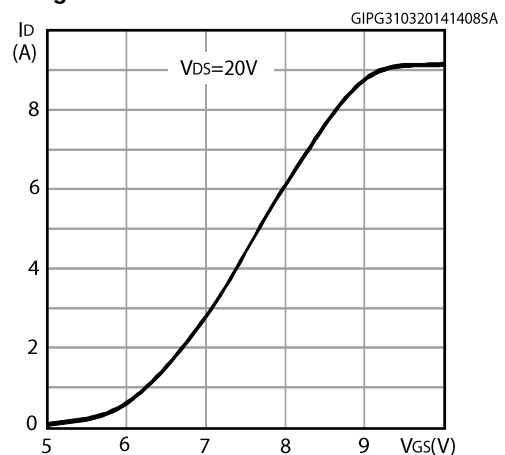


Figure 8: Gate charge vs gate-source voltage

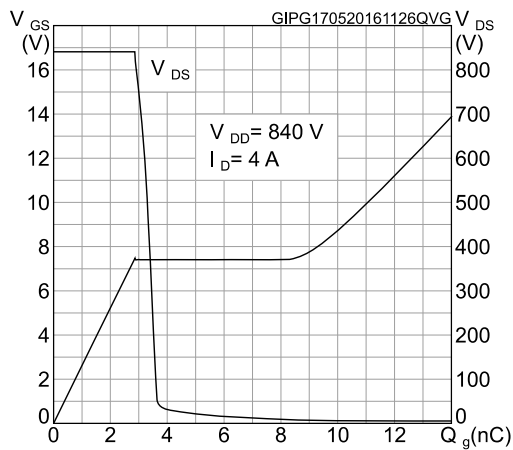


Figure 9: Static drain-source on-resistance

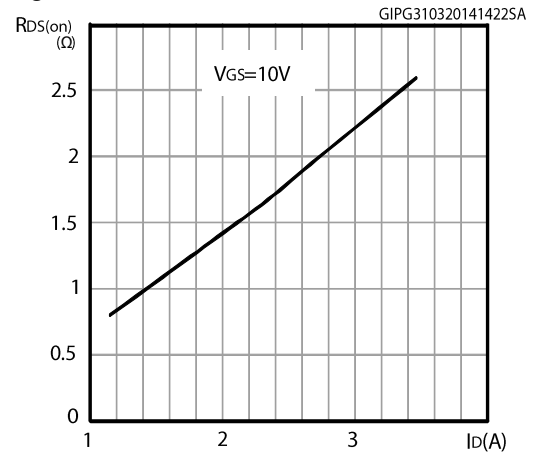


Figure 10: Capacitance variations

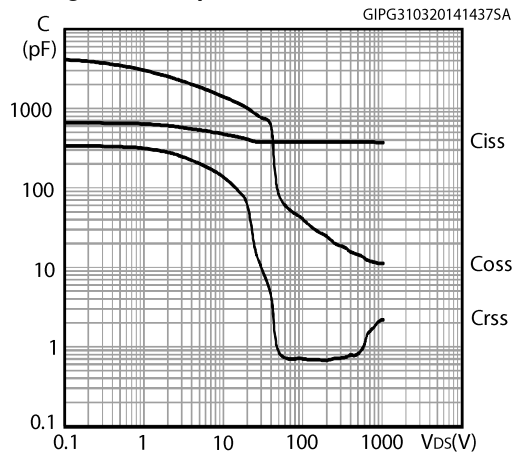


Figure 11: Source-drain diode forward characteristics

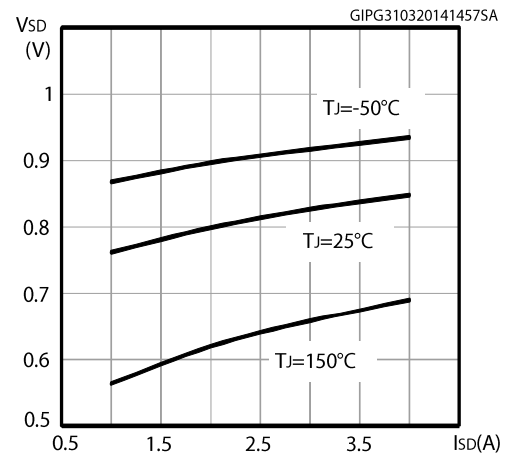


Figure 12: Normalized gate threshold voltage vs temperature

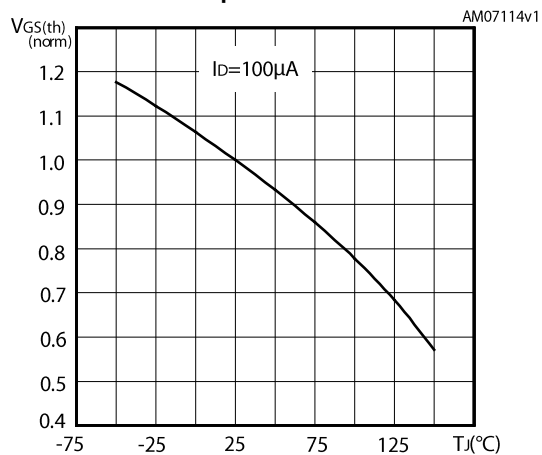


Figure 13: Normalized on-resistance vs temperature

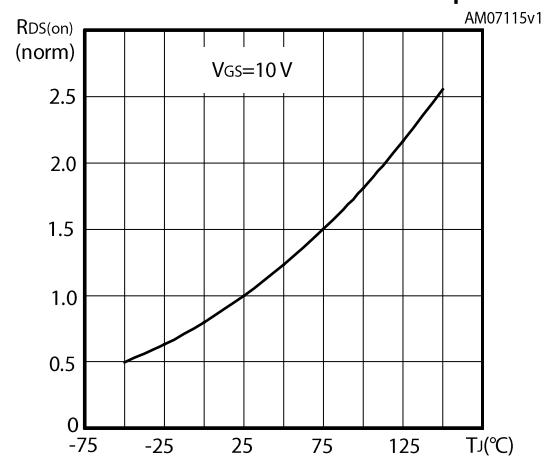


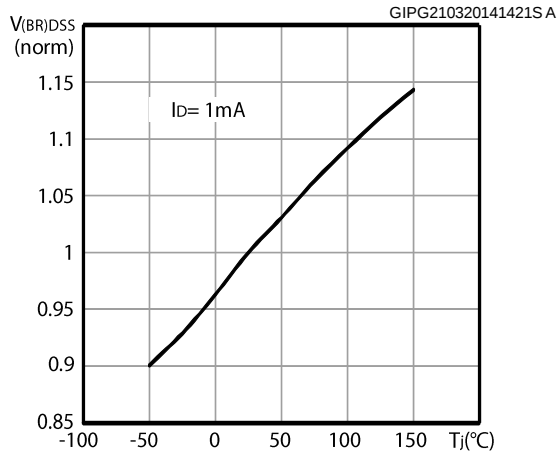
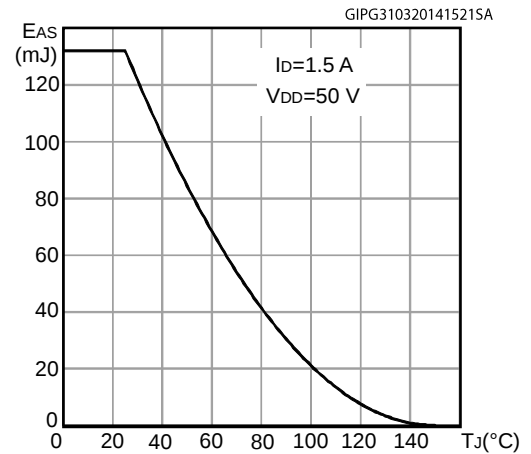
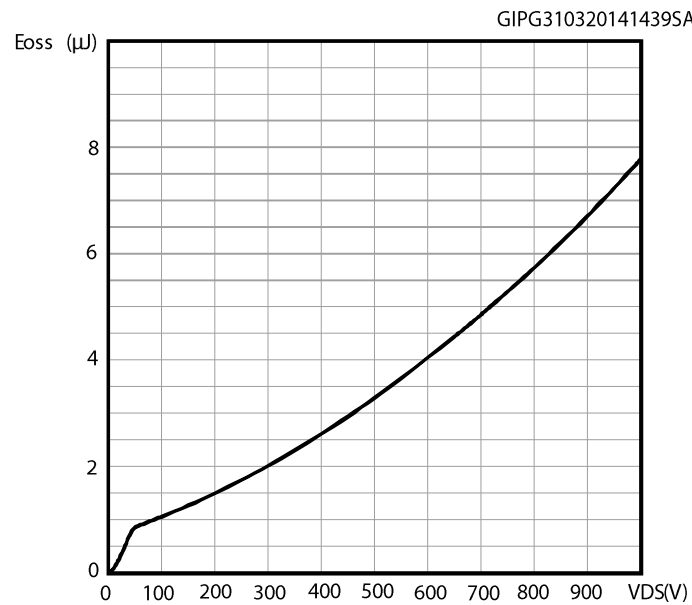
Figure 14: Normalized  $V(BR)_{DSS}$  vs temperatureFigure 15: Maximum avalanche energy vs starting  $T_J$ 

Figure 16: Output capacitance stored energy



### 3 Test circuits

**Figure 17: Test circuit for resistive load switching times**



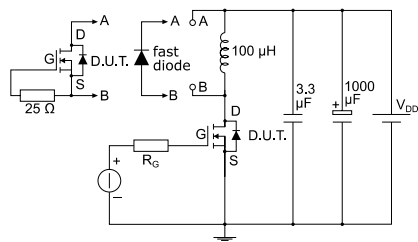
AM01468v1

**Figure 18: Test circuit for gate charge behavior**



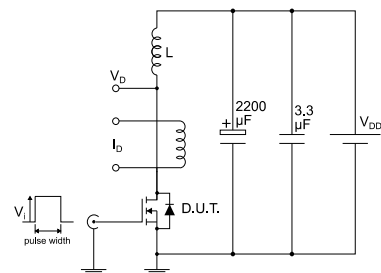
AM01469v1

**Figure 19: Test circuit for inductive load switching and diode recovery times**



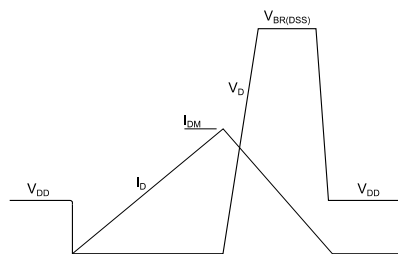
AM01470v1

**Figure 20: Unclamped inductive load test circuit**



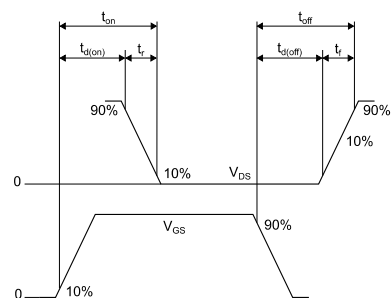
AM01471v1

**Figure 21: Unclamped inductive waveform**



AM01472v1

**Figure 22: Switching time waveform**



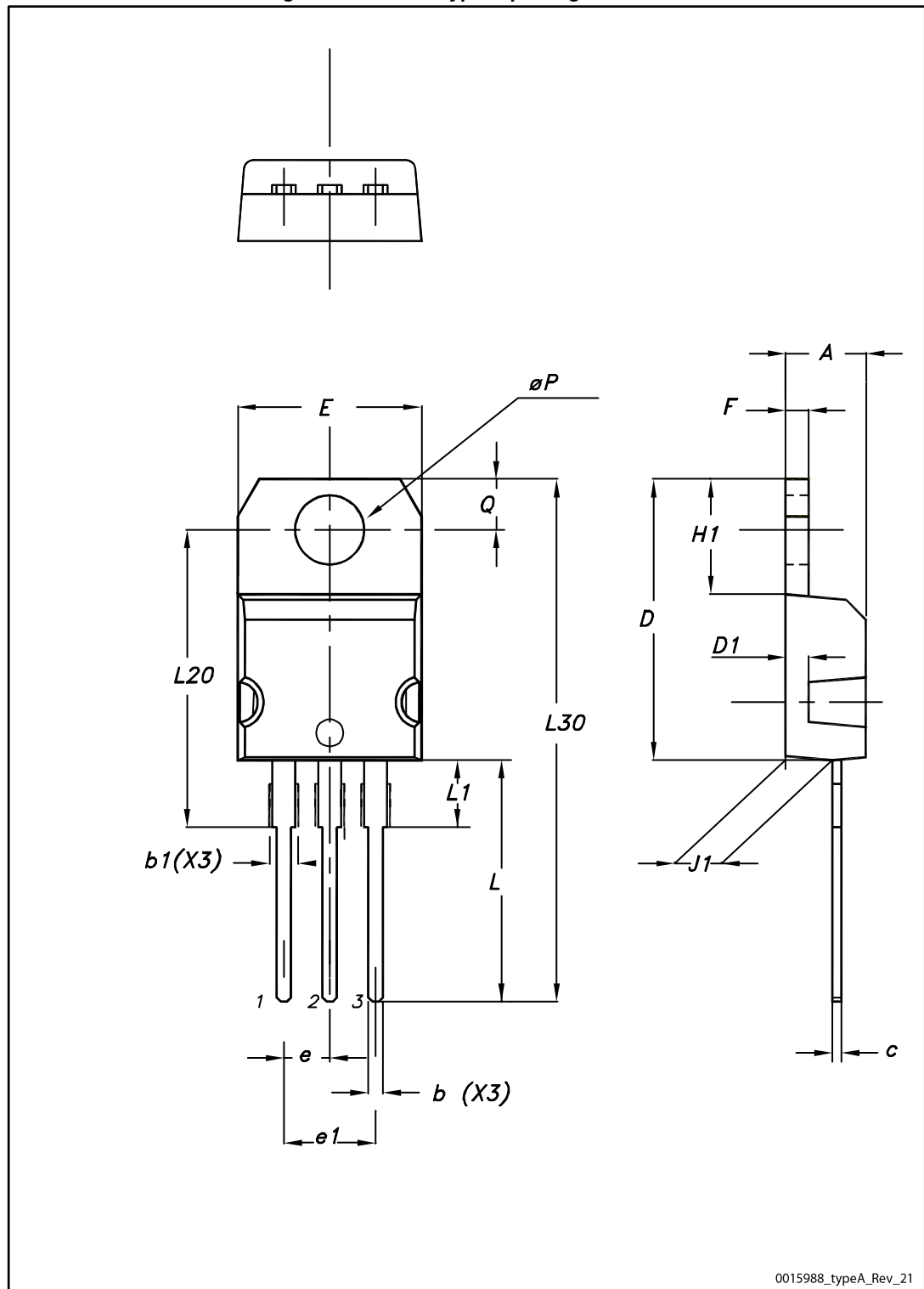
AM01473v1

## 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 package information

Figure 23: TO-220 type A package outline



0015988\_typeA\_Rev\_21

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 IPAK package information

Figure 24: IPAK (TO-251) type A package outline

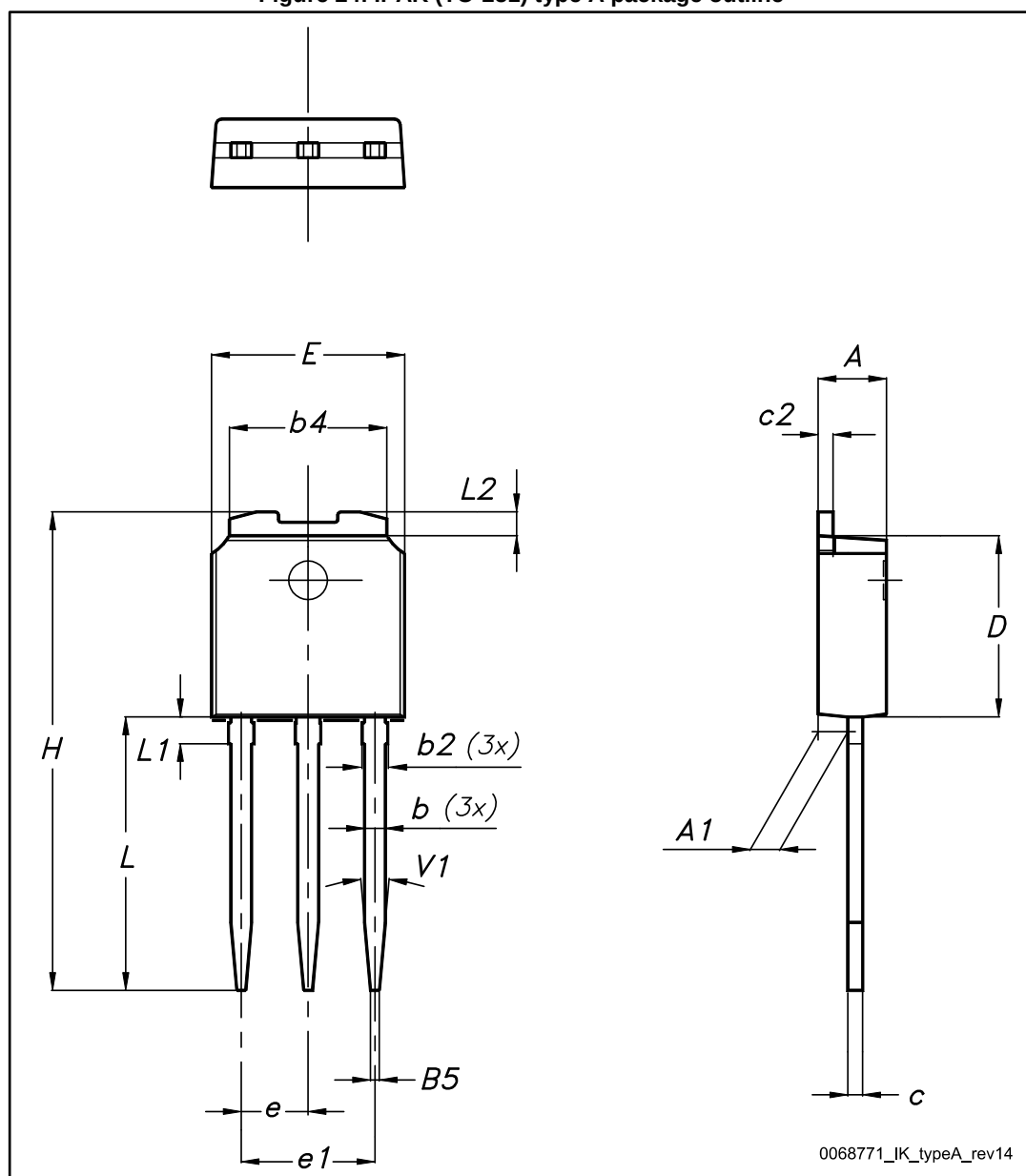


Table 10: IPAK (TO-251) type A package mechanical data

| Dim. | mm   |       |      |
|------|------|-------|------|
|      | Min. | Typ.  | Max. |
| A    | 2.20 |       | 2.40 |
| A1   | 0.90 |       | 1.10 |
| b    | 0.64 |       | 0.90 |
| b2   |      |       | 0.95 |
| b4   | 5.20 |       | 5.40 |
| B5   |      | 0.30  |      |
| c    | 0.45 |       | 0.60 |
| c2   | 0.48 |       | 0.60 |
| D    | 6.00 |       | 6.20 |
| E    | 6.40 |       | 6.60 |
| e    |      | 2.28  |      |
| e1   | 4.40 |       | 4.60 |
| H    |      | 16.10 |      |
| L    | 9.00 |       | 9.40 |
| L1   | 0.80 |       | 1.20 |
| L2   |      | 0.80  | 1.00 |
| V1   |      | 10°   |      |

### 4.3 TO-247 package information

Figure 25: TO-247 package outline

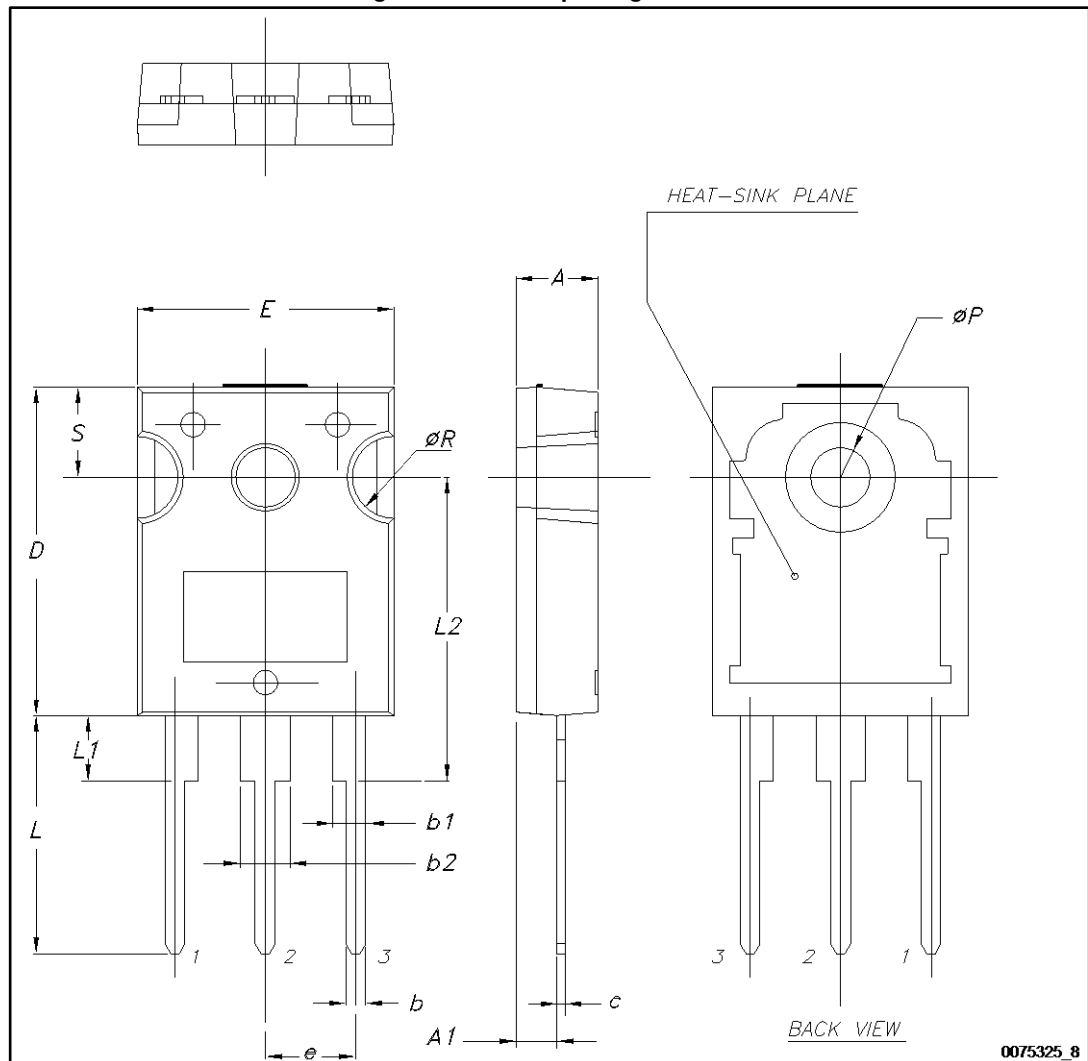


Table 11: TO-247 package mechanical data

| 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 12: Document revision history

| Date        | Revision | Changes                                                                                                                                |
|-------------|----------|----------------------------------------------------------------------------------------------------------------------------------------|
| 07-Apr-2014 | 1        | First release.                                                                                                                         |
| 17-Oct-2016 | 2        | Updated <a href="#">Figure 8: "Gate charge vs gate-source voltage"</a> and <a href="#">Table 5: "Dynamic"</a> .<br>Minor text changes. |

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