

N-channel 1050 V, 1  $\Omega$  typ., 6 A MDmesh™ K5

Power MOSFETs in TO-220, TO-220FP and TO-247 packages

Datasheet - production data

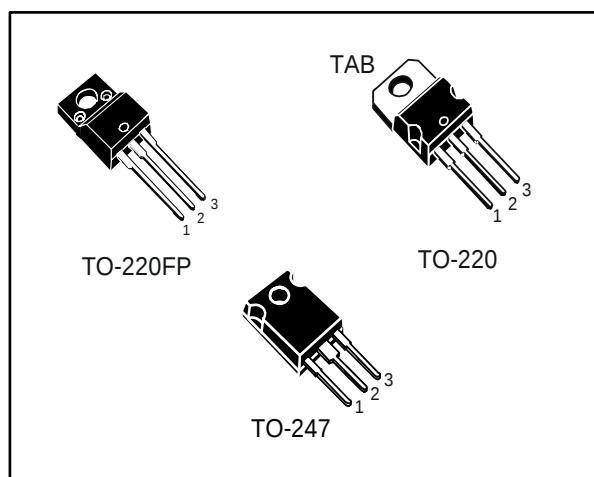
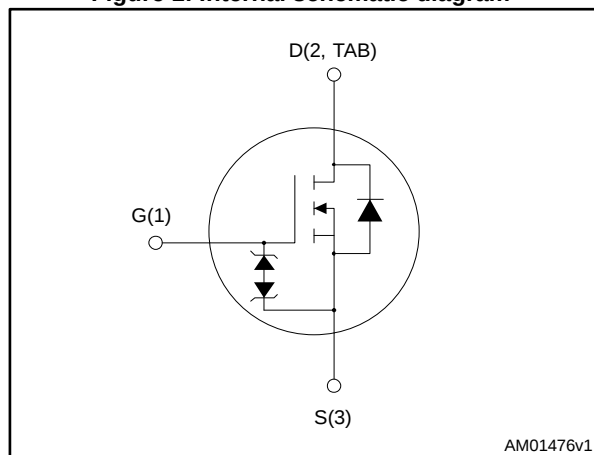


Figure 1: Internal schematic diagram



## Features

| Order codes | $V_{DS}$ | $R_{DS(on)}$<br>max. | $I_D$ | $P_{TOT}$ |
|-------------|----------|----------------------|-------|-----------|
| STF10N105K5 | 1050 V   | 1.3 $\Omega$         | 6 A   | 30 W      |
| STP10N105K5 |          |                      |       | 130 W     |
| STW10N105K5 |          |                      |       | 130 W     |

- Industry's lowest  $R_{DS(on)}$
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

These very high voltage N-channel Power MOSFETs are 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 codes | Marking  | Package  | Packaging |
|-------------|----------|----------|-----------|
| STF10N105K5 | 10N105K5 | TO-220FP | Tube      |
| STP10N105K5 | 10N105K5 | TO-220   | Tube      |
| STW10N105K5 | 10N105K5 | TO-247   | Tube      |

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol             | Parameter                                                                                                                | Value      |        |          | Unit |
|--------------------|--------------------------------------------------------------------------------------------------------------------------|------------|--------|----------|------|
|                    |                                                                                                                          | TO-220     | TO-247 | TO-220FP |      |
| $V_{GS}$           | Gate- source voltage                                                                                                     | 30         |        |          | V    |
| $I_D$              | Drain current (continuous) at $T_C = 25\text{ °C}$                                                                       | 6          |        |          | A    |
| $I_D$              | Drain current (continuous) at $T_C = 100\text{ °C}$                                                                      | 3.78       |        |          | A    |
| $I_{DM}^{(1)}$     | Drain current (pulsed)                                                                                                   | 24         |        |          | A    |
| $P_{TOT}$          | Total dissipation at $T_C = 25\text{ °C}$                                                                                | 130        |        | 30       | W    |
| $I_{AR}$           | Max. current during repetitive or single pulse avalanche                                                                 | 2          |        |          | A    |
| $E_{AS}$           | Single pulse avalanche energy<br>(starting $T_J = 25\text{ °C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ )              | 140        |        |          | mJ   |
| $dv/dt^{(2)}$      | Peak diode recovery voltage slope                                                                                        | 4.5        |        |          | V/ns |
| $dv/dt^{(3)}$      | MOSFET $dv/dt$ ruggedness                                                                                                | 50         |        |          | V/ns |
| $V_{ISO}$          | Insulation withstand voltage (RMS) from all three leads to external heatsink ( $t = 1\text{ s}$ ; $T_C = 25\text{ °C}$ ) | 2500       |        |          | V    |
| $T_J$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature                                                                    | -55 to 150 |        |          | °C   |

**Notes:**<sup>(1)</sup> Pulse width limited by safe operating area.<sup>(2)</sup>  $I_{SD} \leq 6\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{peak} \leq V_{(BR)DSS}$ .<sup>(3)</sup>  $V_{SD} \leq 840$ .

Table 3: Thermal data

| Symbol         | Parameter                                | Value  |        |          | Unit |
|----------------|------------------------------------------|--------|--------|----------|------|
|                |                                          | TO-220 | TO-247 | TO-220FP |      |
| $R_{thj-case}$ | Thermal resistance junction-case max.    | 0.96   |        |          | °C/W |
|                | Thermal resistance junction-case max.    |        |        | 4.2      |      |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max. | 62.50  |        |          | °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                         | I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0                  | 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>DS</sub> = 1050 V, T <sub>C</sub> = 125 °C           |      |      | 50   | μA   |
| I <sub>GSS</sub>     | Gate-body leakage current                              | V <sub>GS</sub> = ± 20 V; V <sub>DS</sub> = 0               |      |      | 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> = 3 A                |      | 1    | 1.3  | Ω    |

Table 5: Dynamic

| Symbol                            | Parameter                             | Test conditions                                                         | Min. | Typ. | Max. | Unit |
|-----------------------------------|---------------------------------------|-------------------------------------------------------------------------|------|------|------|------|
| C <sub>iss</sub>                  | Input capacitance                     | V <sub>DS</sub> = 100 V,<br>f = 1 MHz,<br>V <sub>GS</sub> = 0           | -    | 545  | -    | pF   |
| C <sub>oss</sub>                  | Output capacitance                    |                                                                         |      | 30   |      | pF   |
| C <sub>rss</sub>                  | Reverse transfer capacitance          |                                                                         |      | 1.3  |      | pF   |
| C <sub>o(tr)</sub> <sup>(1)</sup> | Equivalent capacitance time related   | V <sub>GS</sub> = 0, V <sub>DS</sub> = 0<br>to 840 V                    |      | 65   |      | pF   |
| C <sub>o(er)</sub> <sup>(2)</sup> | Equivalent capacitance energy related |                                                                         |      | 22   |      | 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> = 6 A<br>V <sub>GS</sub> = 10 V |      | 21.5 |      | nC   |
| Q <sub>gs</sub>                   | Gate-source charge                    |                                                                         |      | 3.3  |      | nC   |
| Q <sub>gd</sub>                   | Gate-drain charge                     |                                                                         |      | 15.5 |      | 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 <sub>d(on)</sub>  | Turn-on delay time  | V <sub>DD</sub> = 525 V, I <sub>D</sub> = 3 A, R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V | -    | 19   | -    | ns   |
| t <sub>r</sub>      | Rise time           |                                                                                               |      | 8    |      | ns   |
| t <sub>d(off)</sub> | Turn-off-delay time |                                                                                               |      | 50   |      | ns   |
| t <sub>f</sub>      | Fall time           |                                                                                               |      | 21.5 |      | ns   |

Table 7: Source-drain diode

| Symbol                          | Parameter                     | Test conditions                                                                           | Min. | Typ. | Max. | Unit |
|---------------------------------|-------------------------------|-------------------------------------------------------------------------------------------|------|------|------|------|
| I <sub>SD</sub>                 | Source-drain current          |                                                                                           | -    |      | 6    | A    |
| I <sub>SDM</sub> <sup>(1)</sup> | Source-drain current (pulsed) |                                                                                           |      |      | 24   | A    |
| V <sub>SD</sub> <sup>(2)</sup>  | Forward on voltage            | I <sub>SD</sub> = 6 A, V <sub>GS</sub> = 0                                                |      |      | 1.5  | V    |
| t <sub>rr</sub>                 | Reverse recovery time         | I <sub>SD</sub> = 6 A, di/dt = 100 A/μs<br>V <sub>DD</sub> = 60 V                         |      | 345  |      | ns   |
| Q <sub>rr</sub>                 | Reverse recovery charge       |                                                                                           |      | 3.53 |      | μC   |
| I <sub>RRM</sub>                | Reverse recovery current      |                                                                                           |      | 20.5 |      | A    |
| t <sub>rr</sub>                 | Reverse recovery time         | I <sub>SD</sub> = 6 A, di/dt = 100 A/μs<br>V <sub>DD</sub> = 60 V T <sub>J</sub> = 150 °C |      | 540  |      | ns   |
| Q <sub>rr</sub>                 | Reverse recovery charge       |                                                                                           |      | 5.05 |      | μC   |
| I <sub>RRM</sub>                | Reverse recovery current      |                                                                                           |      | 18.5 |      | A    |
|                                 |                               |                                                                                           |      |      |      |      |

**Notes:**

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

<sup>(2)</sup> Pulsed: pulse duration = 300  $\mu\text{s}$ , 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 | $I_{GS} = \pm 1 \text{ mA}$ , $I_D = 0$ | 30   | -    | -    | V    |

The built-in back-to-back Zener diodes have been specifically designed to enhance the ESD capability of the device. The Zener voltage is appropriate for efficient and cost-effective intervention to protect the device integrity. These integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

Figure 2: Safe operating area for TO-220

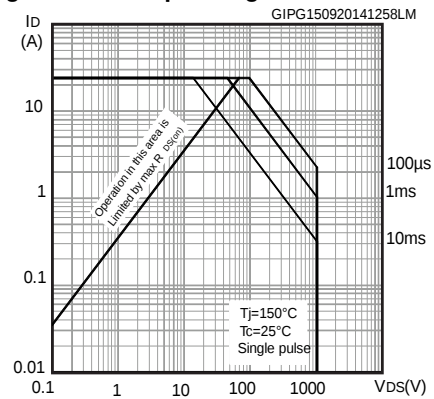


Figure 3: Thermal impedance TO-220

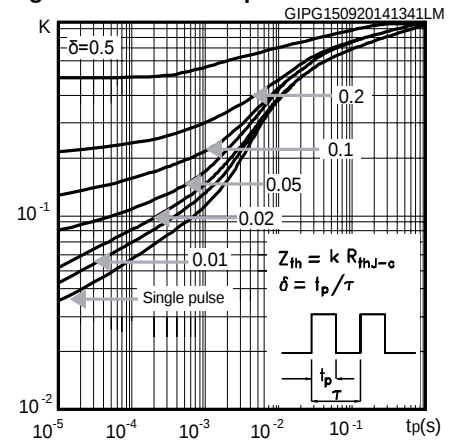


Figure 4: Safe operating area for TO-220FP

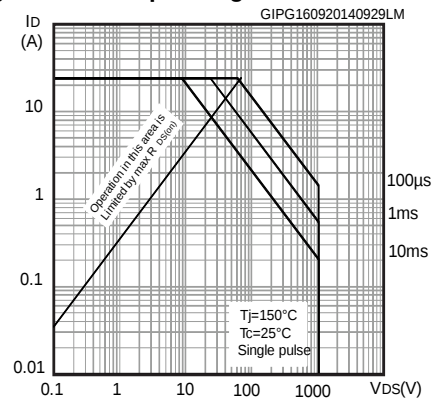


Figure 5: Thermal impedance TO-220FP

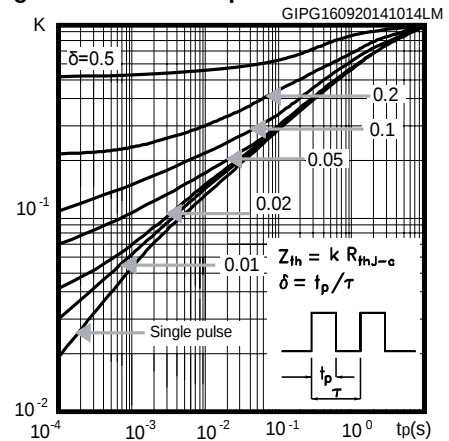


Figure 6: Safe operating area for TO-247

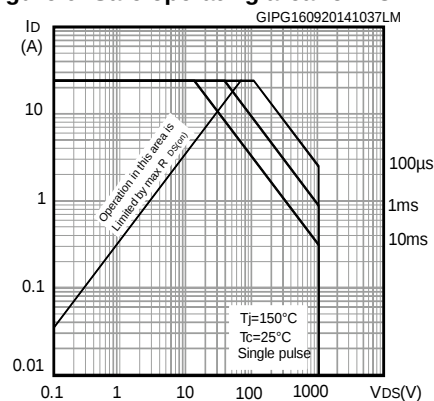


Figure 7: Thermal impedance TO-247

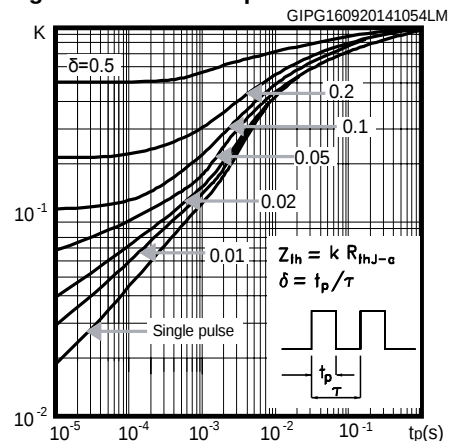


Figure 8: Output characteristics

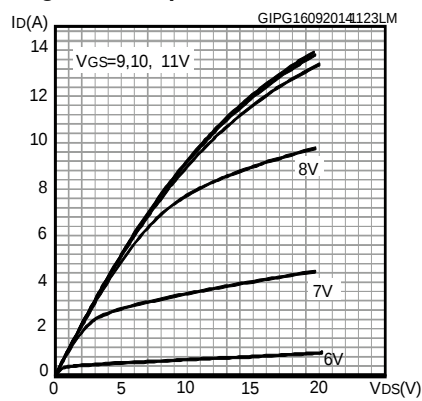


Figure 9: Transfer characteristics

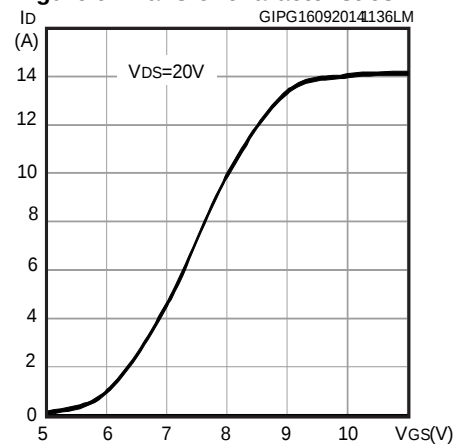


Figure 10: Gate charge vs gate-source voltage

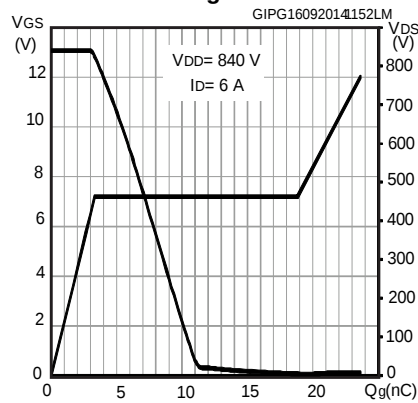


Figure 11: Static drain-source on-resistance

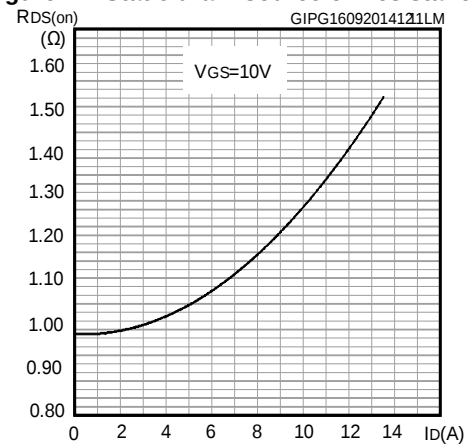


Figure 12: Capacitance variation

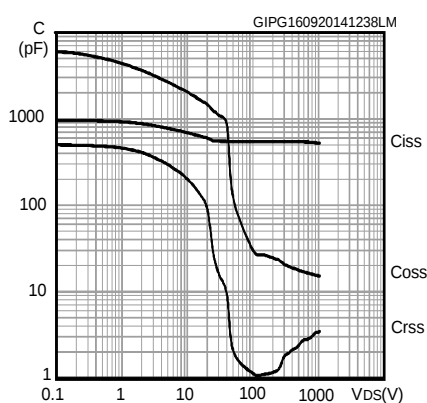
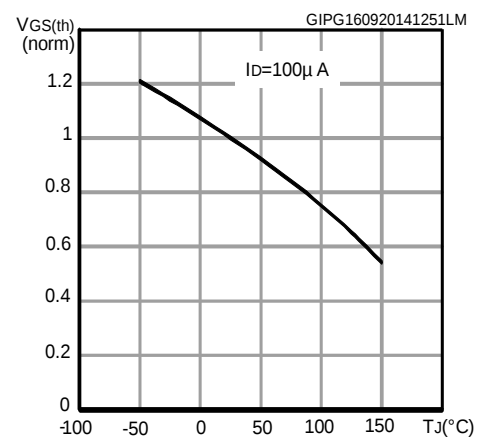
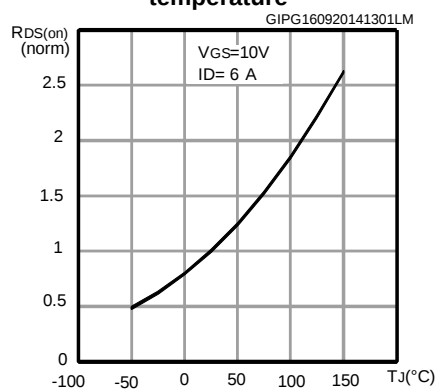
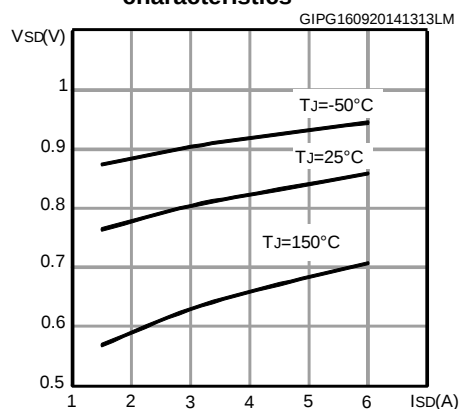
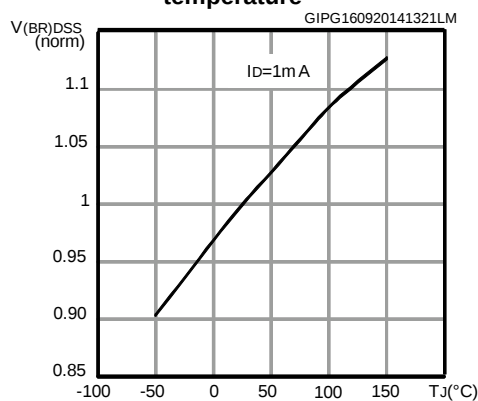
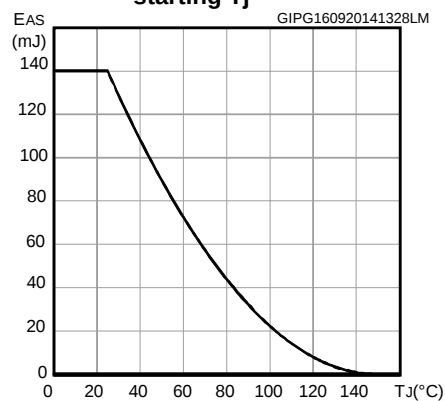


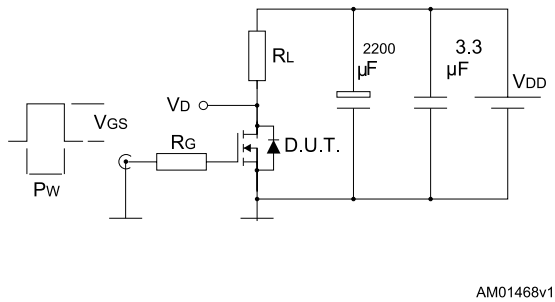
Figure 13: Normalized gate threshold voltage vs temperature



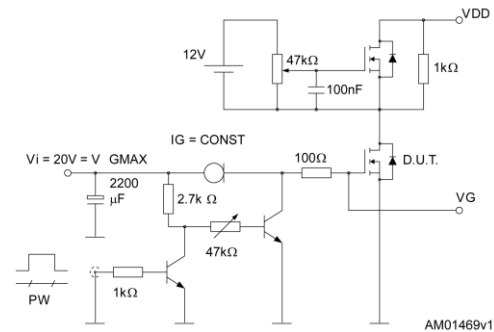
**Figure 14: Normalized on-resistance vs temperature****Figure 15: Source-drain diode forward characteristics****Figure 16: Normalized VBR(DSS) vs temperature****Figure 17: Maximum avalanche energy vs starting  $T_J$** 

### 3 Test circuits

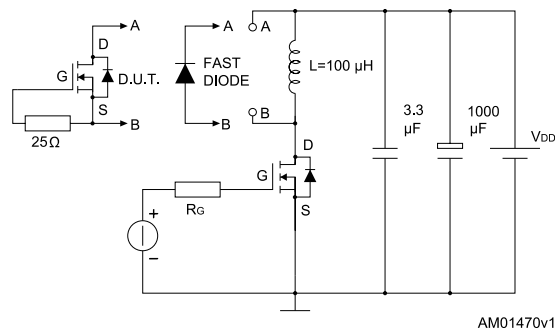
**Figure 18: Switching times test circuit for resistive load**



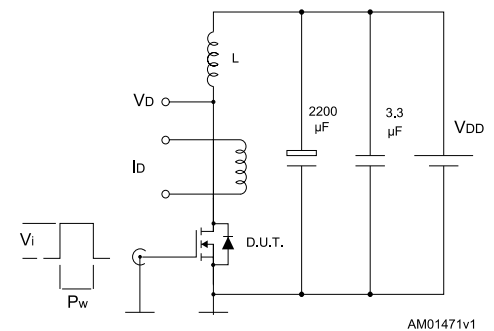
**Figure 19: Gate charge test circuit**



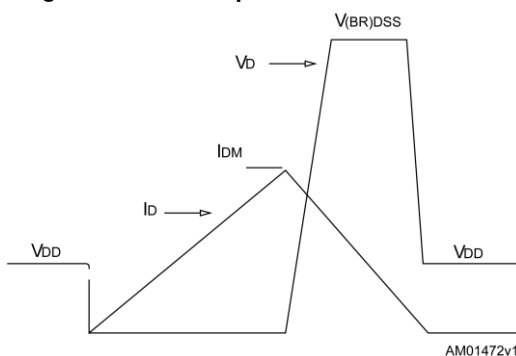
**Figure 20: Test circuit for inductive load switching and diode recovery times**



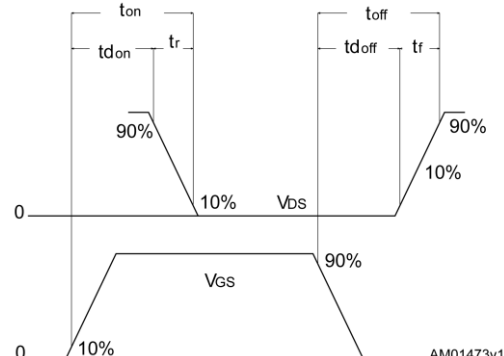
**Figure 21: Unclamped inductive load test circuit**



**Figure 22: Unclamped inductive waveform**



**Figure 23: Switching time waveform**



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: **[www.st.com](http://www.st.com)**. ECOPACK<sup>®</sup> is an ST trademark.

## 4.1 TO-220 package mechanical data

Figure 24: TO-220 type A drawings

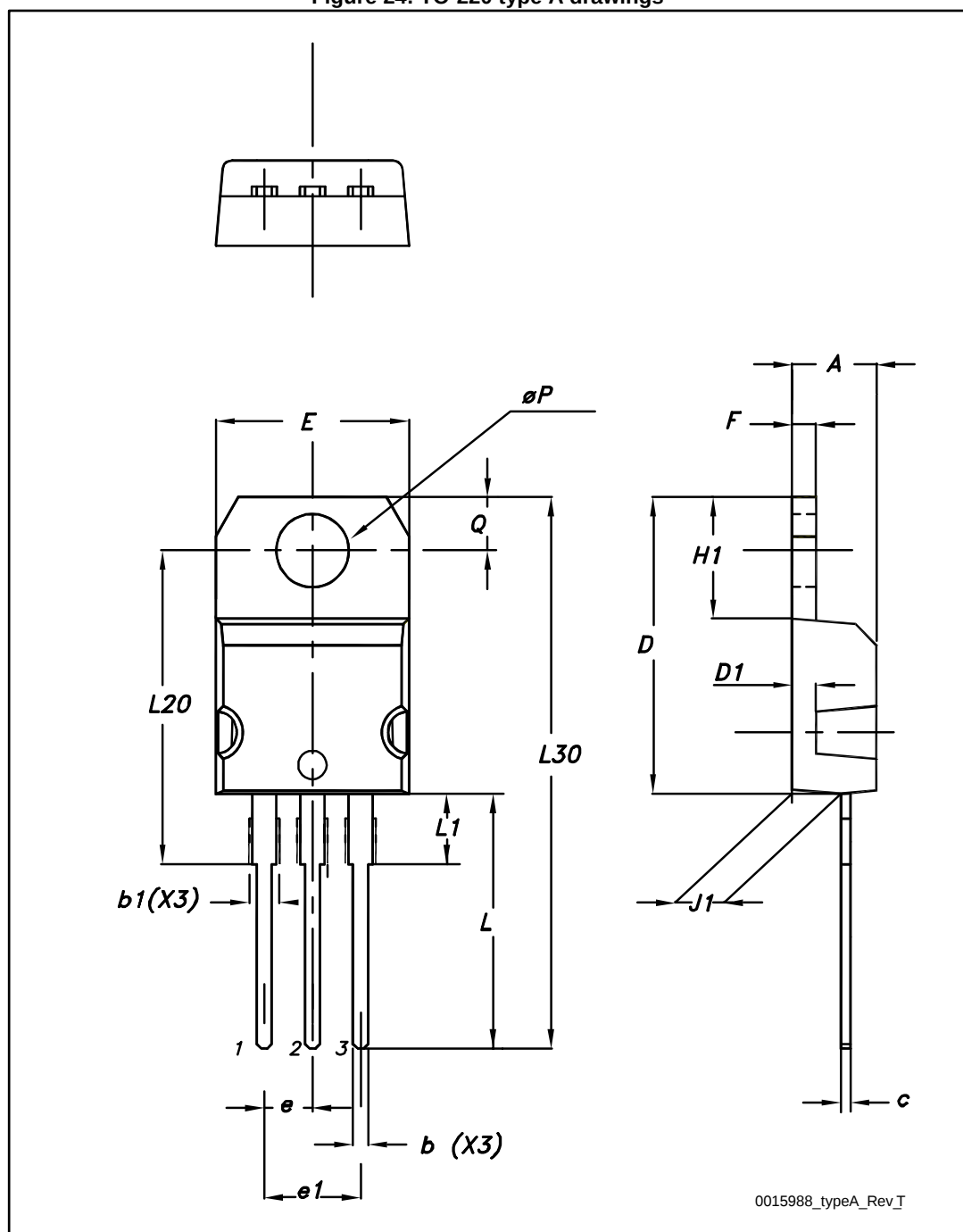


Table 9: TO-220 type A mechanical data

| 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 mechanical data

Figure 25: TO-247 drawings

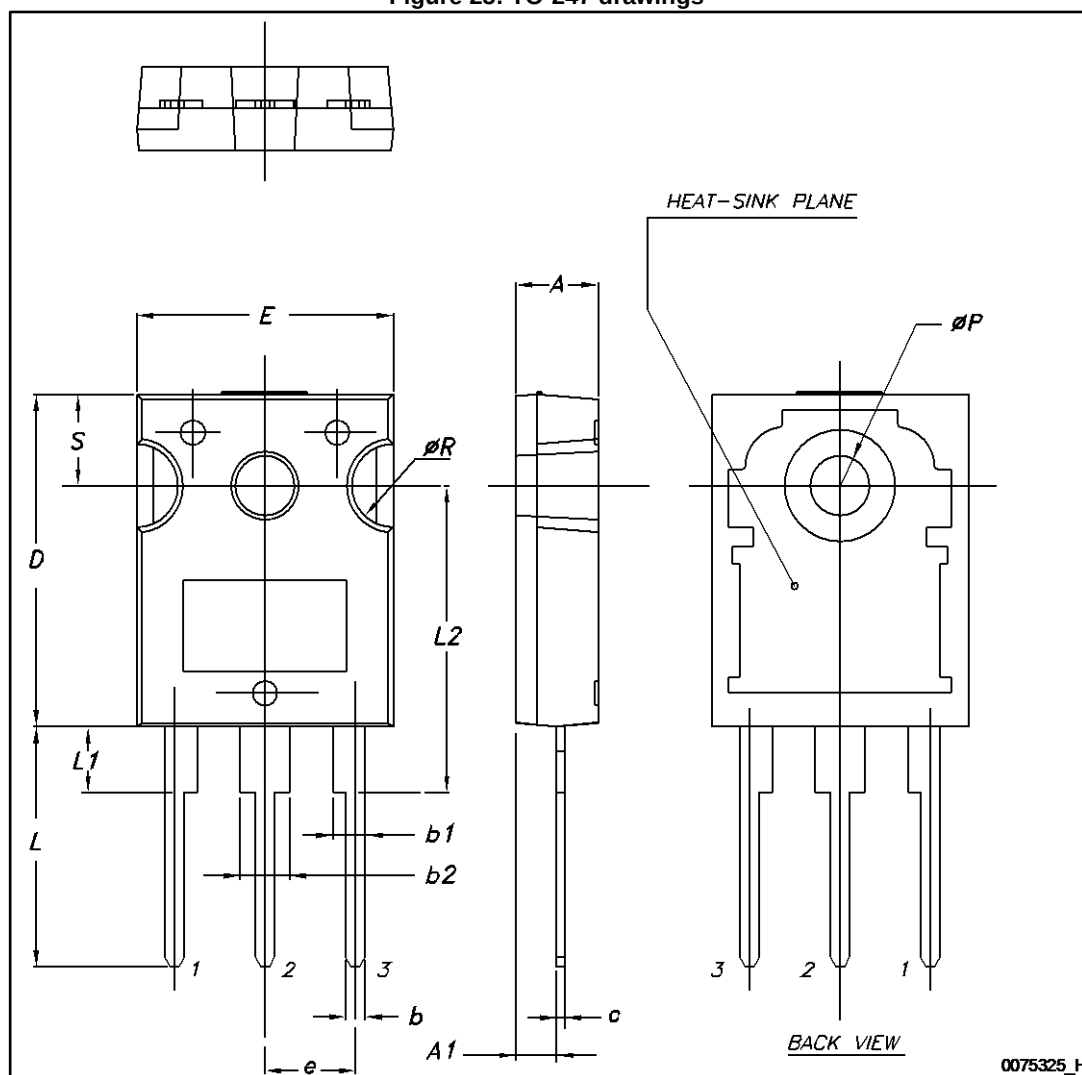
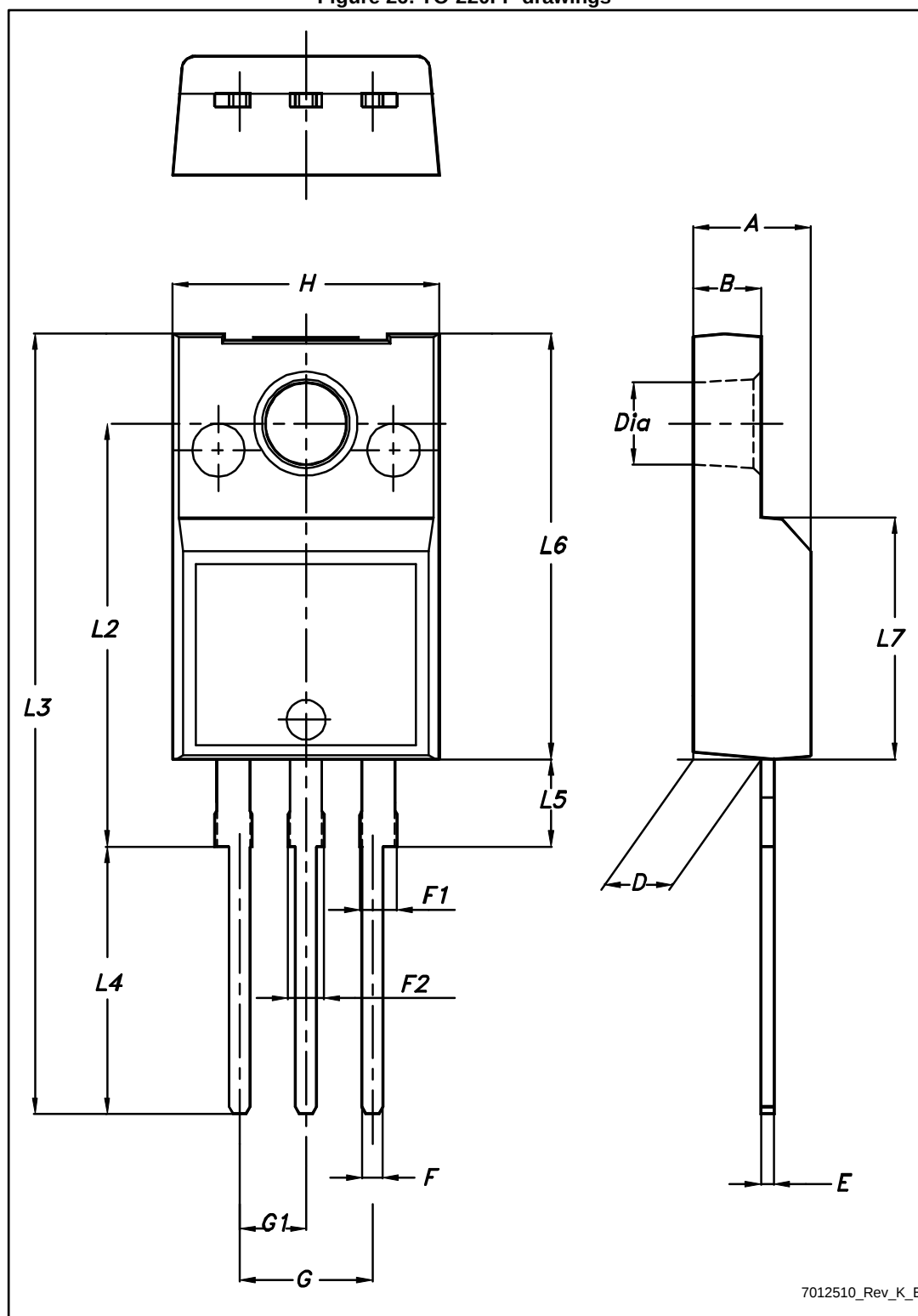


Table 10: TO-247 mechanical data

| 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 |       |
| øP   | 3.55  |       | 3.65  |
| øR   | 4.50  |       | 5.50  |
| S    | 5.30  | 5.50  | 5.70  |

**4.3 TO-220FP package mechanical data**

Figure 26: TO-220FP drawings



7012510\_Rev\_K\_B

Table 11: TO-220FP mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 4.4  |      | 4.6  |
| B    | 2.5  |      | 2.7  |
| D    | 2.5  |      | 2.75 |
| E    | 0.45 |      | 0.7  |
| F    | 0.75 |      | 1    |
| F1   | 1.15 |      | 1.70 |
| F2   | 1.15 |      | 1.70 |
| G    | 4.95 |      | 5.2  |
| G1   | 2.4  |      | 2.7  |
| H    | 10   |      | 10.4 |
| L2   |      | 16   |      |
| L3   | 28.6 |      | 30.6 |
| L4   | 9.8  |      | 10.6 |
| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Ø    | 3    |      | 3.2  |

## 5 Revision history

**Table 12: Document revision history**

| Date        | Revision | Changes                                                       |
|-------------|----------|---------------------------------------------------------------|
| 07-Oct-2014 | 1        | First release.                                                |
| 14-Oct-2014 | 2        | Document status promoted from preliminary to production data. |

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