

## Automotive-grade N-channel 60 V, 0.012 $\Omega$ typ., 60 A STripFET™ II Power MOSFET in a D<sup>2</sup>PAK package

Datasheet - production data

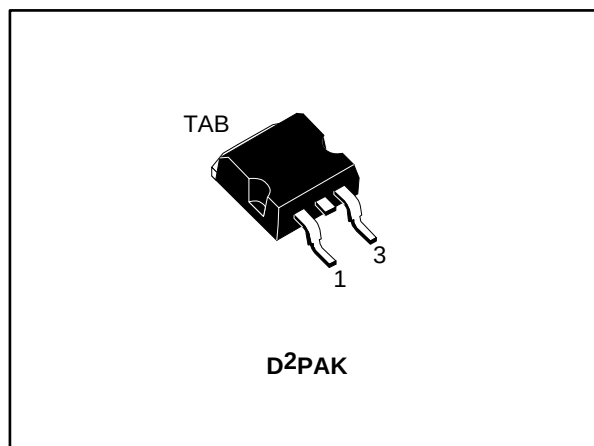
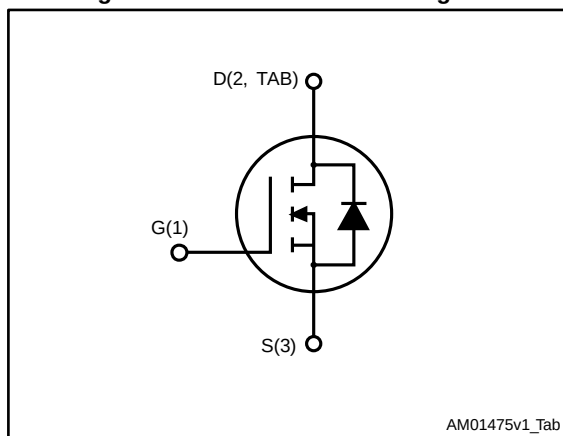


Figure 1: Internal schematic diagram



### Features

| Order code   | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | P <sub>TOT</sub> |
|--------------|-----------------|--------------------------|----------------|------------------|
| STB60NF06LT4 | 60 V            | 0.014 $\Omega$           | 60 A           | 110 W            |

- Designed for automotive applications and AEC-Q101 qualified
- Exceptional dv/dt capability
- 100% avalanche tested
- Application-oriented characterization
- 175°C operating range
- Low threshold drive

### Applications

- Switching applications

### Description

This Power MOSFET series realized with STMicroelectronics unique STripFET™ process is specifically designed to minimize input capacitance and gate charge. It is therefore ideal as a primary switch in advanced high-efficiency isolated DC-DC converters for Telecom and Computer applications. It is also suitable for any application with low gate charge drive requirements.

Table 1: Device summary

| Order code   | Marking  | Package            | Packing       |
|--------------|----------|--------------------|---------------|
| STB60NF06LT4 | B60NF06L | D <sup>2</sup> PAK | Tape and reel |

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## Contents

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol         | Parameter                                                            | Value      | Unit             |
|----------------|----------------------------------------------------------------------|------------|------------------|
| $V_{DSS}$      | Drain-source voltage ( $V_{GS} = 0\text{ V}$ )                       | 60         | V                |
| $V_{DGR}$      | Drain-gate voltage ( $R_{GS} = 20\text{ k}\Omega$ )                  | 60         | V                |
| $V_{GS}$       | Gate-source voltage                                                  | $\pm 15$   | V                |
| $I_D$          | Drain current (continuous) at $T_{case} = 25\text{ }^\circ\text{C}$  | 60         | A                |
|                | Drain current (continuous) at $T_{case} = 100\text{ }^\circ\text{C}$ | 42         |                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                               | 240        | A                |
| $P_{TOT}$      | Total dissipation at $T_{case} = 25\text{ }^\circ\text{C}$           | 110        | W                |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                                    | 20         | V/ns             |
| $T_{stg}$      | Storage temperature                                                  | -65 to 175 | $^\circ\text{C}$ |
| $T_j$          | Operating junction temperature                                       |            |                  |

**Notes:**

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

<sup>(2)</sup>  $I_{SD} \leq 60\text{ A}$ ,  $di/dt \leq 600\text{ A}/\mu\text{s}$ ;  $T_j \leq T_{jmax}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .

Table 3: Thermal data

| Symbol              | Parameter                        | Value | Unit                      |
|---------------------|----------------------------------|-------|---------------------------|
| $R_{thj-case}$      | Thermal resistance junction-case | 1.36  | $^\circ\text{C}/\text{W}$ |
| $R_{thj-PCB}^{(1)}$ | Thermal resistance junction-PCB  | 35    |                           |

**Notes:**

<sup>(1)</sup> When mounted on a 1-inch<sup>2</sup> FR-4, 2 Oz copper board.

Table 4: Avalanche characteristics

| Symbol         | Parameter                     | Value | Unit |
|----------------|-------------------------------|-------|------|
| $E_{AS}^{(1)}$ | Single pulse avalanche energy | 320   | mJ   |

**Notes:**

<sup>(1)</sup> starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = 30\text{ A}$ ,  $V_{DD} = 30\text{ V}$ .

## 2 Electrical characteristics

( $T_{\text{case}} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified)

**Table 5: Static**

| Symbol                      | Parameter                         | Test conditions                                                                                                   | Min. | Typ.  | Max.      | Unit          |
|-----------------------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------|------|-------|-----------|---------------|
| $V_{(\text{BR})\text{DSS}}$ | Drain-source breakdown voltage    | $V_{\text{GS}} = 0\text{ V}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$                                            | 60   |       |           | V             |
| $I_{\text{DSS}}$            | Zero gate voltage drain current   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 60\text{ V}$                                                      |      |       | 1         | $\mu\text{A}$ |
|                             |                                   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 60\text{ V}$ ,<br>$T_{\text{case}} = 125\text{ }^{\circ}\text{C}$ |      |       | 10        |               |
| $I_{\text{GSS}}$            | Gate-body leakage current         | $V_{\text{DS}} = 0\text{ V}$ , $V_{\text{GS}} = \pm 15\text{ V}$                                                  |      |       | $\pm 100$ | nA            |
| $V_{\text{GS(th)}}$         | Gate threshold voltage            | $V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$                                         | 1    |       | 2.5       | V             |
| $R_{\text{DS(on)}}$         | Static drain-source on-resistance | $V_{\text{GS}} = 5\text{ V}$ , $I_{\text{D}} = 30\text{ A}$                                                       |      | 0.014 | 0.016     | $\Omega$      |
|                             |                                   | $V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 30\text{ A}$                                                      |      | 0.012 | 0.014     |               |

**Table 6: Dynamic**

| Symbol           | Parameter                    | Test conditions                                                                                                                                                                                       | Min. | Typ. | Max. | Unit |
|------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{\text{iss}}$ | Input capacitance            | $V_{\text{DS}} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{\text{GS}} = 0\text{ V}$                                                                                                                  | -    | 2000 | -    | pF   |
| $C_{\text{oss}}$ | Output capacitance           |                                                                                                                                                                                                       | -    | 360  | -    |      |
| $C_{\text{rss}}$ | Reverse transfer capacitance |                                                                                                                                                                                                       | -    | 125  | -    |      |
| $Q_{\text{g}}$   | Total gate charge            | $V_{\text{DD}} = 48\text{ V}$ , $I_{\text{D}} = 60\text{ A}$ ,<br>$V_{\text{GS}} = 4.5\text{ V}$ , $R_{\text{G}} = 4.7\text{ }\Omega$ (see<br><a href="#">Figure 14: "Gate charge test circuit"</a> ) | -    | 35   | 66   | nC   |
| $Q_{\text{gs}}$  | Gate-source charge           |                                                                                                                                                                                                       | -    | 10   | -    |      |
| $Q_{\text{gd}}$  | Gate-drain charge            |                                                                                                                                                                                                       | -    | 20   | -    |      |

**Table 7: Switching times**

| Symbol              | Parameter           | Test conditions                                                                                                                                                                                                                                                                          | Min. | Typ. | Max. | Unit |
|---------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{\text{d(on)}}$  | Turn-on delay time  | $V_{\text{DD}} = 30\text{ V}$ , $I_{\text{D}} = 30\text{ A}$ ,<br>$R_{\text{G}} = 4.7\text{ }\Omega$ , $V_{\text{GS}} = 4.5\text{ V}$ (see<br><a href="#">Figure 13: "Switching times test circuit for resistive load"</a><br>and <a href="#">Figure 18: "Switching time waveform"</a> ) | -    | 35   | -    | ns   |
| $t_{\text{r}}$      | Rise time           |                                                                                                                                                                                                                                                                                          | -    | 220  | -    |      |
| $t_{\text{d(off)}}$ | Turn-off delay time |                                                                                                                                                                                                                                                                                          | -    | 55   | -    |      |
| $t_{\text{f}}$      | Fall time           |                                                                                                                                                                                                                                                                                          | -    | 30   | -    |      |

Table 8: Source-drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                   | -    |      | 60   | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                   | -    |      | 240  | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 60\text{ A}$                                                                                                                                                                    | -    |      | 1.3  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 60\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 30\text{ V}$ , $T_j = 150\text{ °C}$ (see<br><i>Figure 15: "Test circuit for inductive load switching and diode recovery times")</i> ) | -    | 110  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                   | -    | 250  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                   | -    | 4.5  |      | A    |

**Notes:**

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

<sup>(2)</sup> Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

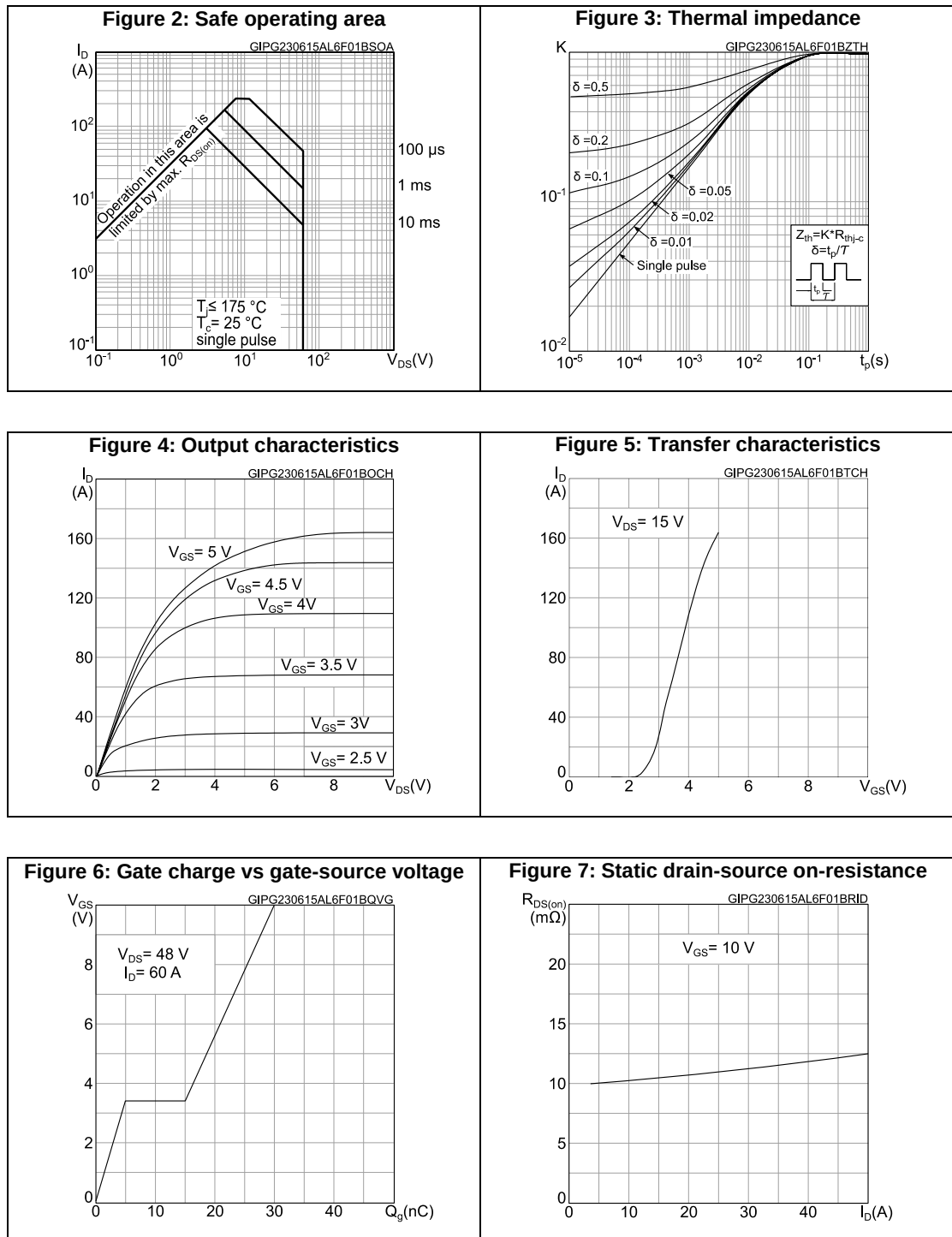


Figure 8: Capacitance variations

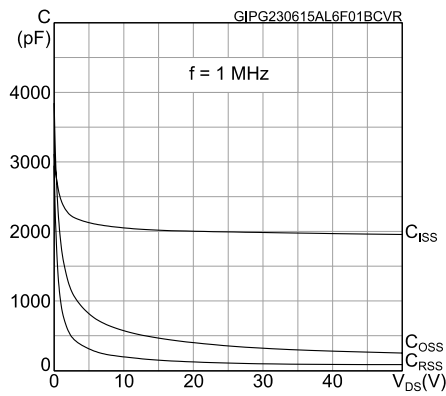


Figure 9: Normalized gate threshold voltage vs temperature

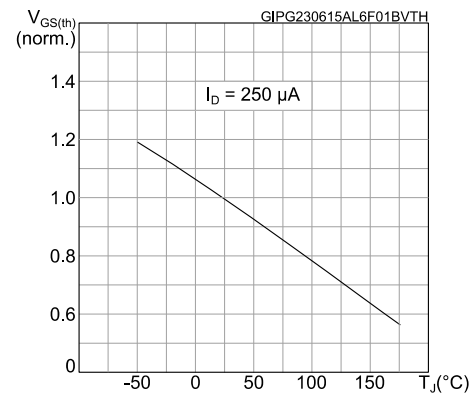


Figure 10: Normalized on-resistance vs temperature

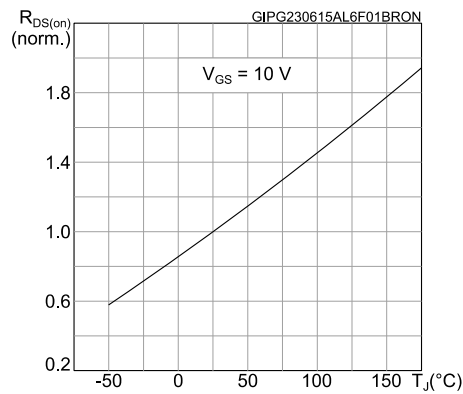


Figure 11: Normalized V(BR)DSS vs temperature

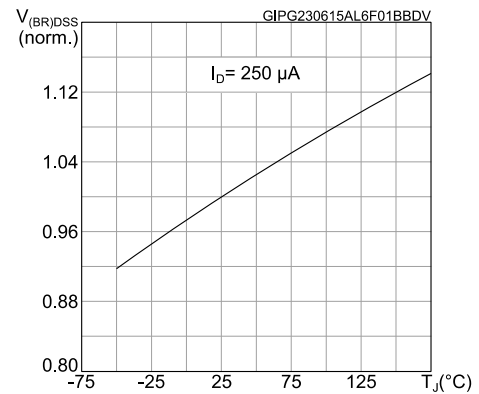
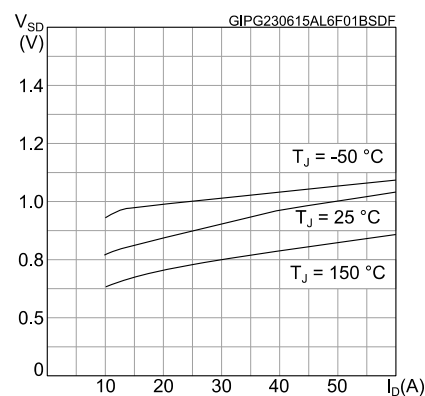
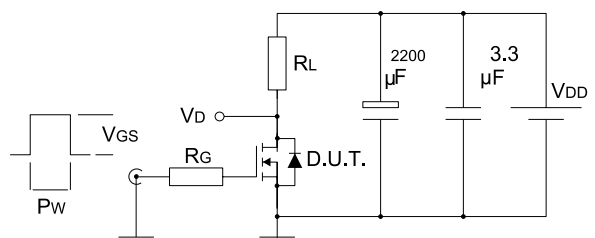


Figure 12: Source-drain diode forward characteristics



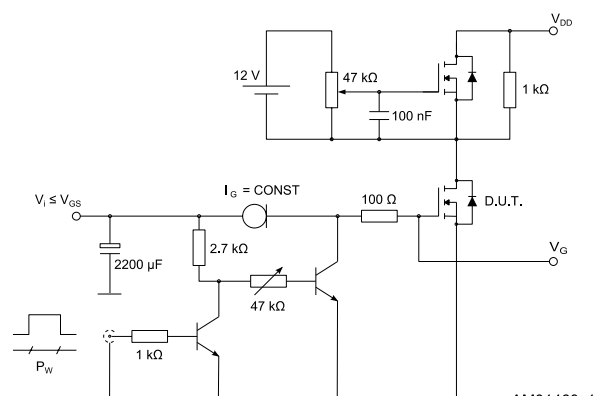
### 3 Test circuits

**Figure 13: Switching times test circuit for resistive load**



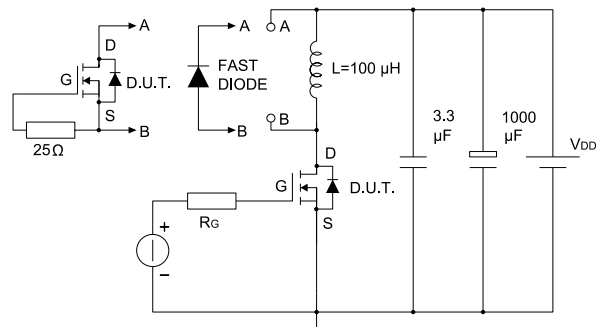
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**Figure 14: Gate charge test circuit**



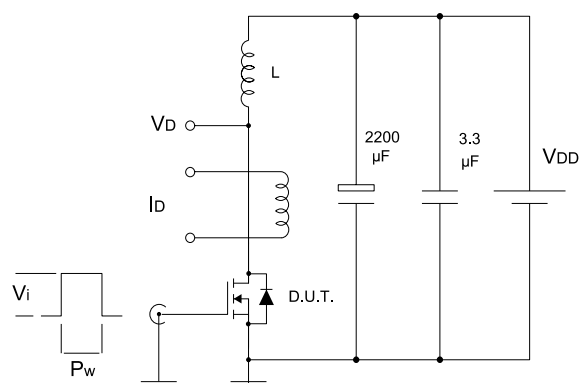
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**Figure 15: Test circuit for inductive load switching and diode recovery times**



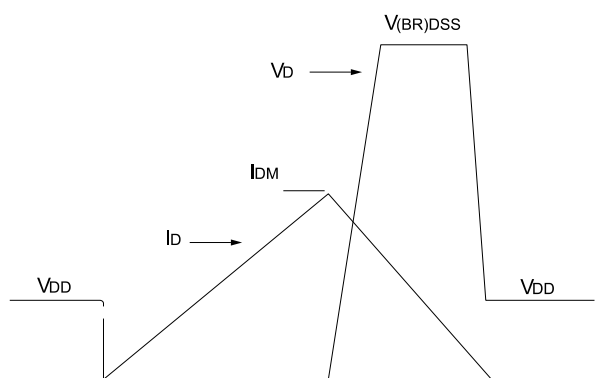
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**Figure 16: Unclamped inductive load test circuit**



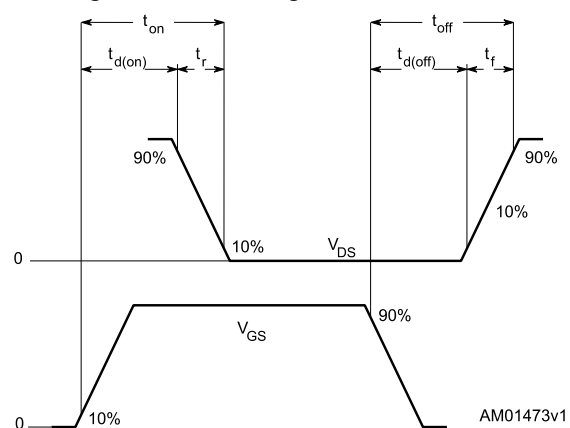
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**Figure 17: Unclamped inductive waveform**



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**Figure 18: Switching time waveform**



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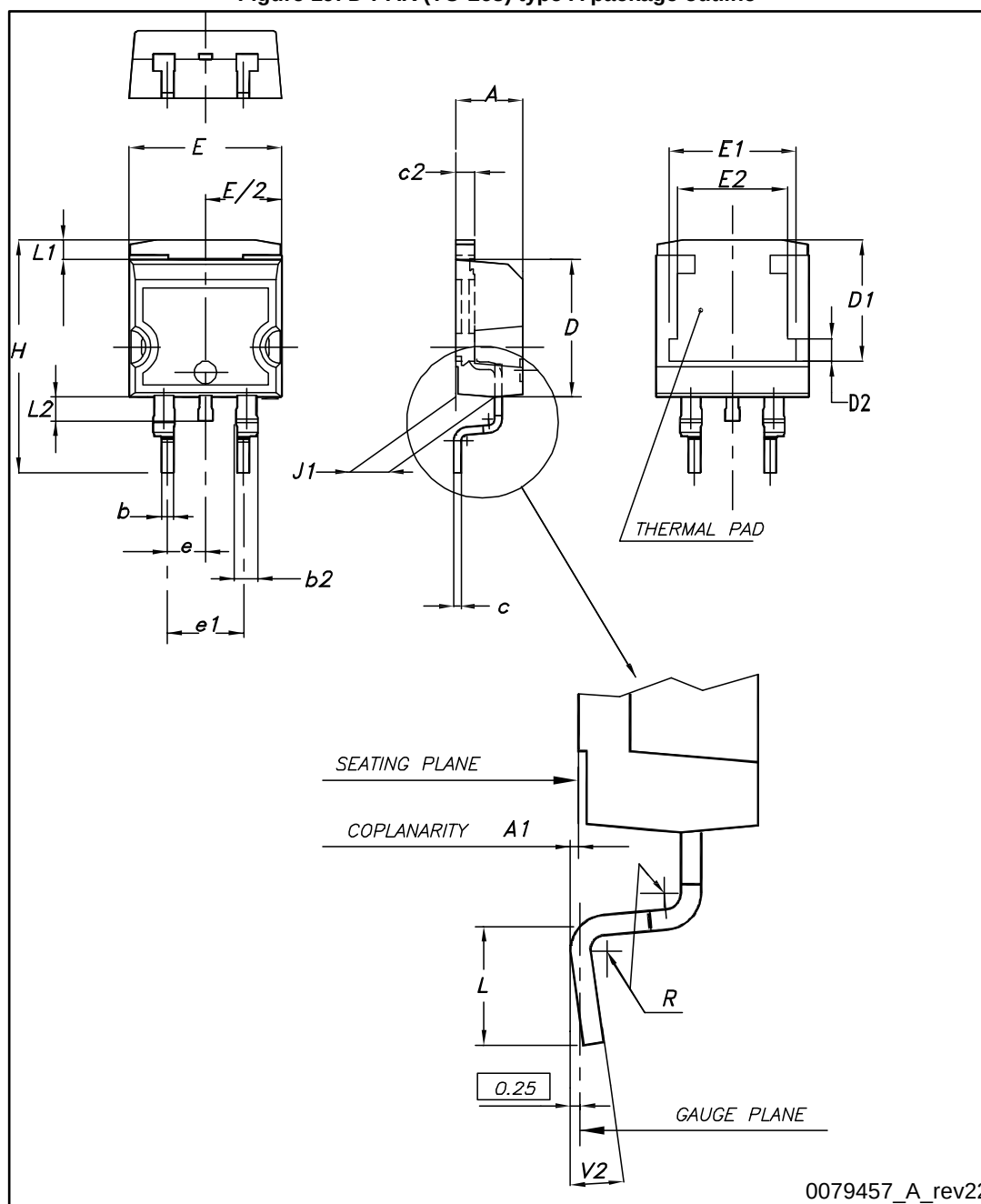


## 4 Package information

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 D<sup>2</sup>PAK (TO-263) type A package information

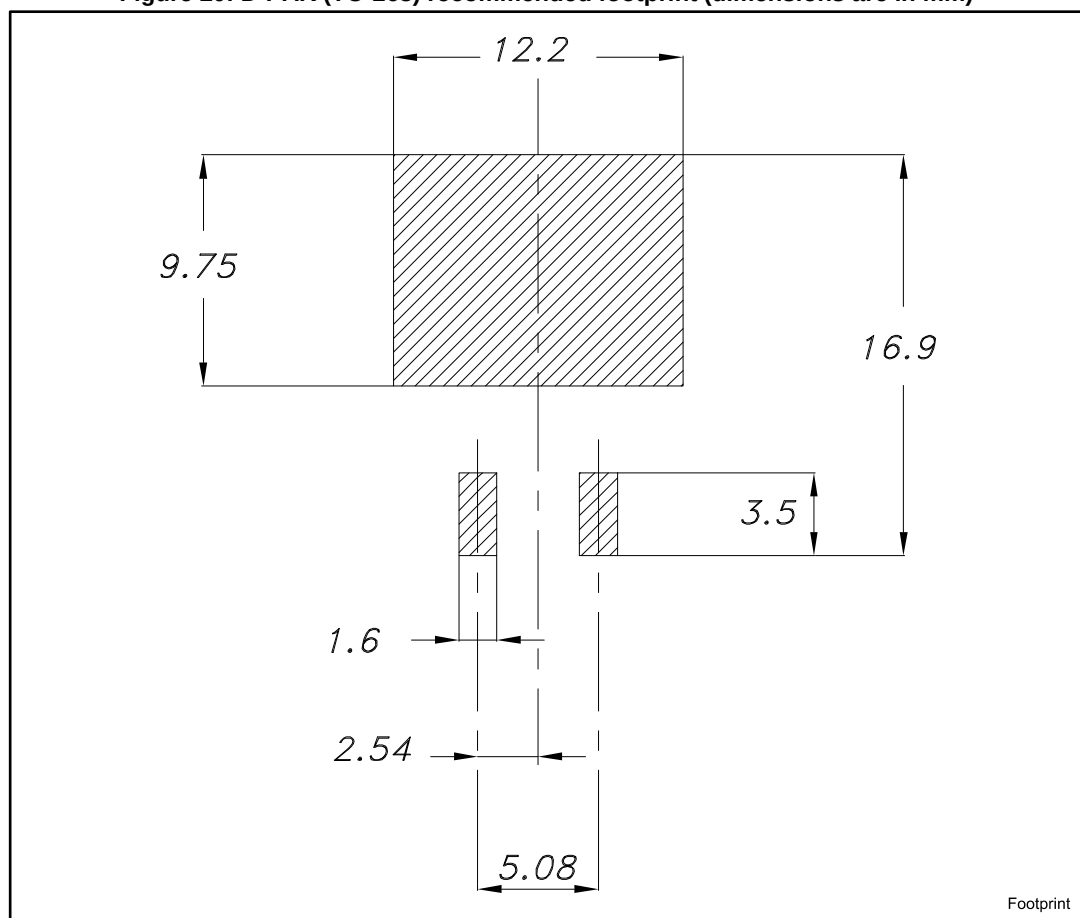
Figure 19: D<sup>2</sup>PAK (TO-263) type A package outline



0079457\_A\_rev22

Table 9: D<sup>2</sup>PAK (TO-263) type A package mechanical data

| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 4.40 |      | 4.60  |
| A1   | 0.03 |      | 0.23  |
| b    | 0.70 |      | 0.93  |
| b2   | 1.14 |      | 1.70  |
| c    | 0.45 |      | 0.60  |
| c2   | 1.23 |      | 1.36  |
| D    | 8.95 |      | 9.35  |
| D1   | 7.50 | 7.75 | 8.00  |
| D2   | 1.10 | 1.30 | 1.50  |
| E    | 10   |      | 10.40 |
| E1   | 8.50 | 8.70 | 8.90  |
| E2   | 6.85 | 7.05 | 7.25  |
| e    |      | 2.54 |       |
| e1   | 4.88 |      | 5.28  |
| H    | 15   |      | 15.85 |
| J1   | 2.49 |      | 2.69  |
| L    | 2.29 |      | 2.79  |
| L1   | 1.27 |      | 1.40  |
| L2   | 1.30 |      | 1.75  |
| R    |      | 0.4  |       |
| V2   | 0°   |      | 8°    |

Figure 20: D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)

## 4.2 D<sup>2</sup>PAK packing information

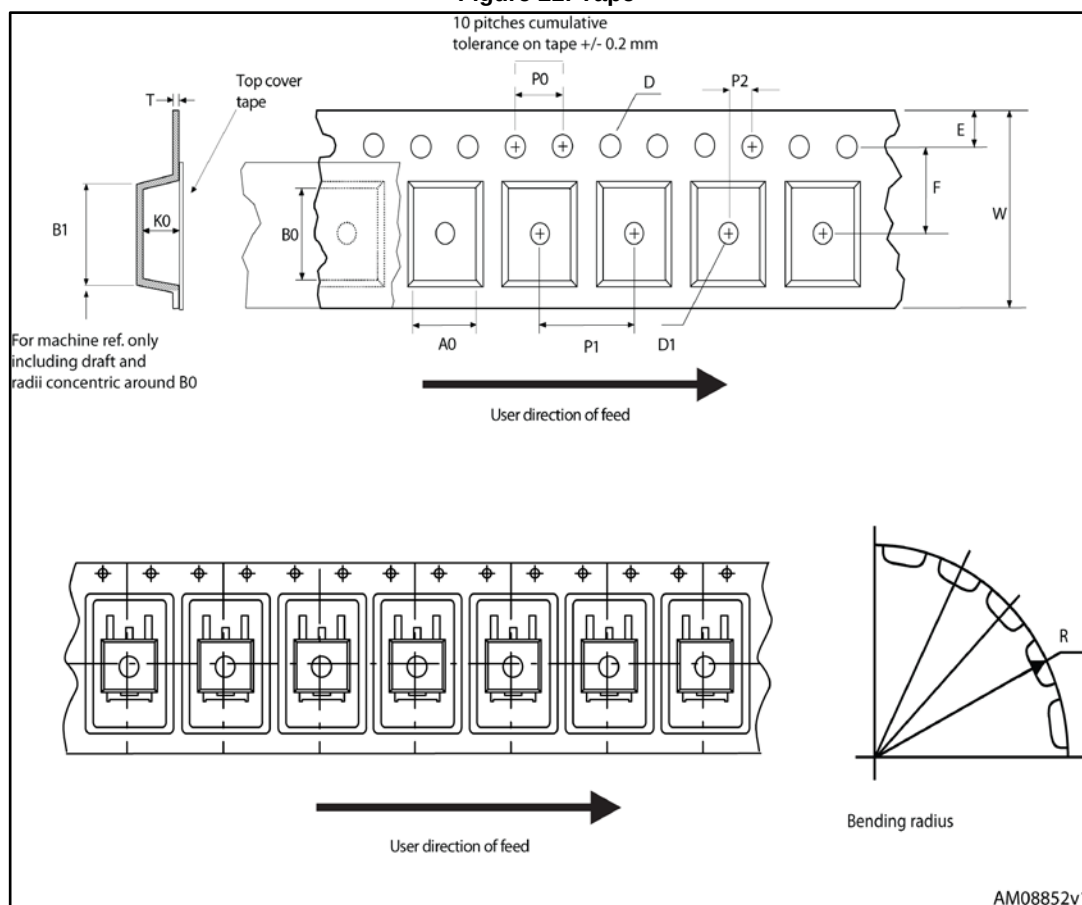
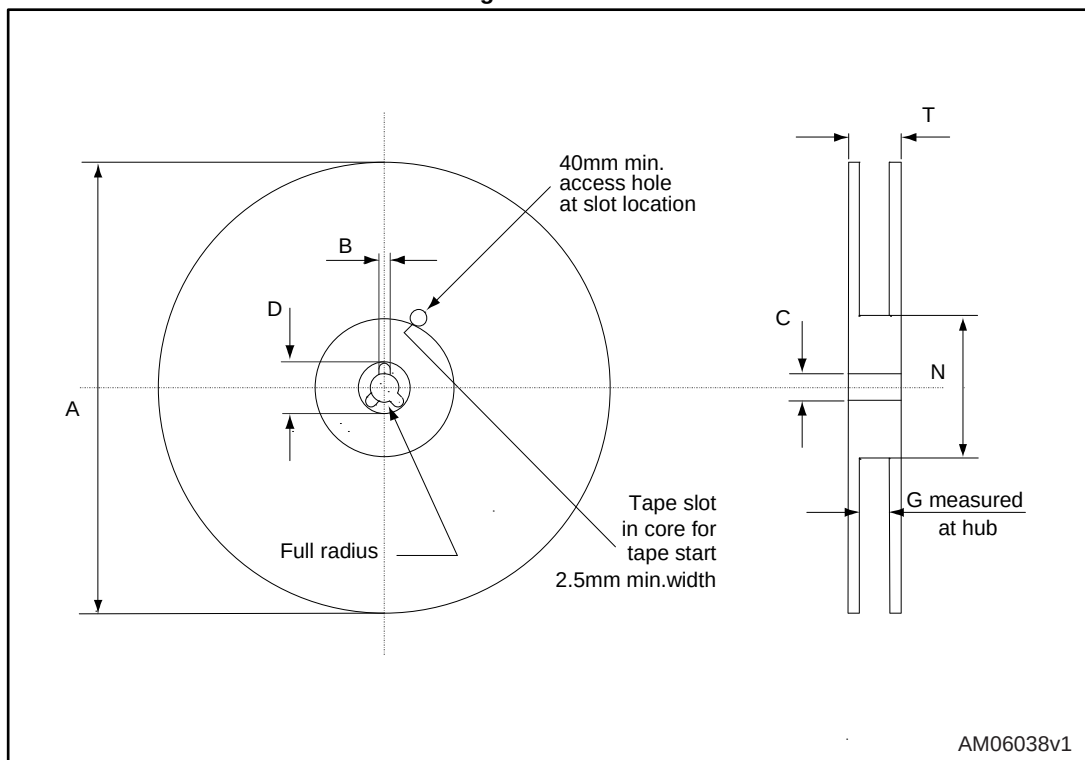
**Figure 21: Tape**

Figure 22: Reel

Table 10: D<sup>2</sup>PAK tape and reel mechanical data

| Tape |      |      | Reel     |      |      |
|------|------|------|----------|------|------|
| Dim. | mm   |      | Dim.     | mm   |      |
|      | Min. | Max. |          | Min. | Max. |
| A0   | 10.5 | 10.7 | A        |      | 330  |
| B0   | 15.7 | 15.9 | B        | 1.5  |      |
| D    | 1.5  | 1.6  | C        | 12.8 | 13.2 |
| D1   | 1.59 | 1.61 | D        | 20.2 |      |
| E    | 1.65 | 1.85 | G        | 24.4 | 26.4 |
| F    | 11.4 | 11.6 | N        | 100  |      |
| K0   | 4.8  | 5.0  | T        |      | 30.4 |
| P0   | 3.9  | 4.1  |          |      |      |
| P1   | 11.9 | 12.1 | Base qty |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk qty |      | 1000 |
| R    | 50   |      |          |      |      |
| T    | 0.25 | 0.35 |          |      |      |
| W    | 23.7 | 24.3 |          |      |      |

## 5 Revision history

Table 11: Document revision history

| Date        | Revision | Changes        |
|-------------|----------|----------------|
| 24-Jun-2015 | 1        | First release. |

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