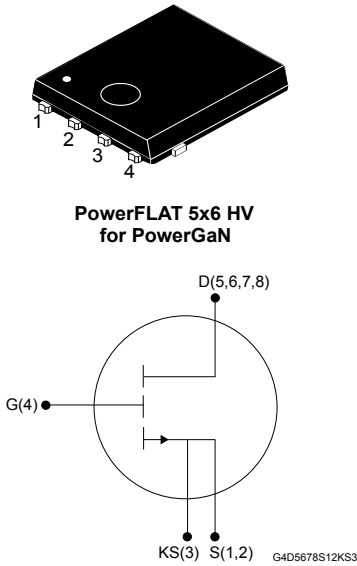


## 650 V, 49 mΩ typ., 25 A, e-mode PowerGaN transistor



## Product status link

[SGT65R65AL](#)

## Product summary

| Product summary |                                  |
|-----------------|----------------------------------|
| Order code      | SGT65R65AL                       |
| Marking         | 65R65A                           |
| Package         | PowerFLAT 5x6 HV<br>for PowerGaN |
| Packing         | Tape and reel                    |

## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ | Series |
|------------|----------|-------------------|-------|--------|
| SGT65R65AL | 650 V    | 65 mΩ             | 25 A  | G-HEMT |

- Enhancement mode normally off transistor
- Very high switching speed
- High power management capability
- Extremely low capacitances
- Kelvin source pad for optimum gate driving
- Zero reverse recovery charge

## Applications

- AC-DC converters
- AC-DC PSU for server and telecom
- LED illumination
- Uninterruptable power supplies (UPS)

## Description

The SGT65R65AL is a 650 V, 25 A e-mode PowerGaN transistor combined with a well established packaging technology. The resulting G-HEMT device provides extremely low conduction losses, high current capability and ultra fast switching operation to enable high power density and unbeatable efficiency performances.

# 1 Electrical ratings

$T_C = 25\text{ °C}$  unless otherwise specified.

**Table 1. Absolute maximum ratings**

| Symbol      | Parameter   | Value      | Unit |
|-------------|---|------------|------|
| $V_{DS}$    | Drain-source voltage                                      | 650        | V    |
|             | Drain-source voltage (transient, $t_p < 1\ \mu\text{s}$ ) | 750        |      |
| $V_{GS}$    | Gate-source voltage                                       | -10 to 7   | V    |
| $I_D^{(1)}$ | Drain current (continuous) at $T_C = 25\text{ °C}$        | 25         | A    |
|             | Drain current (continuous) at $T_C = 100\text{ °C}$       | 25         |      |
| $I_{DM}$    | Pulse drain current ( $t_p = 100\ \mu\text{s}$ )          | 70         | A    |
| $P_{TOT}$   | Total power dissipation at $T_C = 25\text{ °C}$           | 305        | W    |
|             | Total power dissipation at $T_A = 25\text{ °C}$           | 5          |      |
| $T_{stg}$   | Storage temperature range                                 | -55 to 150 | °C   |
| $T_J$       | Operating junction temperature range                      |            | °C   |

1. Limited by package.

**Table 2. Thermal data**

| Symbol              | Parameter                               | Value | Unit |
|---------------------|---|-------|------|
| $R_{thJC}^{(1)}$    | Thermal resistance, junction-to-case    | 0.41  | °C/W |
| $R_{thJA}^{(1)(2)}$ | Thermal resistance, junction-to-ambient | 25    | °C/W |

1. Specified by design, not tested in production.

2. Device mounted on 1.6 mm thick, FR4, 4-layer PCB with 2 oz. copper on each layer. The recommendation for thermal vias under the thermal pad are 0.3 mm diameter (12 mil) with 0.635 mm pitch (25 mil). The copper layers under the thermal pad and drain pad are 25 x 25 mm each. The PCB is mounted in horizontal position without air stream cooling.

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified.

**Table 3. Static**

| Symbol        | Parameter                         | Test conditions   | Min. | Typ. | Max. | Unit          |
|---------------|-----------------------------------|---|------|------|------|---------------|
| $V_{(BL)DSS}$ | Drain-source blocking voltage     | $V_{GS} = 0\text{ V}, I_D \leq 10\text{ }\mu\text{A}$             | 650  |      |      | V             |
| $I_{DSS}$     | Drain-source leakage current      | $V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V}$                      |      | 0.5  |      | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V}, T_J = 150\text{ °C}$ |      | 50   |      |               |
| $I_{GSS}$     | Gate-source leakage current       | $V_{DS} = 0\text{ V}, V_{GS} = 6\text{ V}$                        |      | 100  |      | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = 0.01\text{ V}, I_D = 2.3\text{ mA}$                     |      | 1.8  |      | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 6\text{ V}, I_D = 15\text{ A}$                          |      | 49   | 65   | m $\Omega$    |
|               |                                   | $V_{GS} = 6\text{ V}, I_D = 15\text{ A}, T_J = 150\text{ °C}$     |      | 116  |      |               |

**Table 4. Dynamic**

| Symbol            | Parameter                                    | Test conditions   | Min. | Typ. | Max. | Unit     |
|-------------------|--|---|------|------|------|----------|
| $C_{iss}$         | Input capacitance                            | $V_{GS} = 0\text{ V}, V_{DS} = 400\text{ V}, f = 1\text{ MHz}$  | -    | 286  | -    | pF       |
| $C_{oss}$         | Output capacitance                           |   | -    | 85   | -    | pF       |
| $C_{riss}$        | Reverse transfer capacitance                 |   | -    | 3    | -    | pF       |
| $C_{o(er)}^{(1)}$ | Equivalent output capacitance energy related | $V_{GS} = 0\text{ V}, V_{DS} = 0\text{ to }400\text{ V}$  | -    | 125  | -    | pF       |
| $C_{o(tr)}^{(2)}$ | Equivalent output capacitance time related   |   | -    | 156  | -    | pF       |
| $R_G$             | Intrinsic gate resistance                    | $f = 5\text{ MHz}, I_D = 0\text{ A}$  | -    | 1.2  | -    | $\Omega$ |
| $V_{plat}$        | Gate plateau voltage                         | $V_{DS} = 400\text{ V}, I_D = 15\text{ A}$  | -    | 2.5  | -    | V        |
| $Q_g$             | Total gate charge                            | $V_{GS} = 0\text{ to }6\text{ V}, V_{DS} = 400\text{ V}, I_D = 15\text{ A}$<br>(see Figure 19. Test circuit for gate charge behavior) | -    | 5.4  | -    | nC       |
| $Q_{gs}$          | Gate-source charge                           |   | -    | 1.3  | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                            |   | -    | 1.9  | -    | nC       |
| $Q_{rr}$          | Reverse recovery charge                      | $V_{GS} = 0\text{ V}, V_{DS} = 400\text{ V}$  | -    | 0    | -    | nC       |
| $Q_{oss}$         | Output charge                                |   | -    | 70   | -    | nC       |

- $C_{o(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to the stated value.
- $C_{o(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to the stated value.

**Table 5. Switching times**

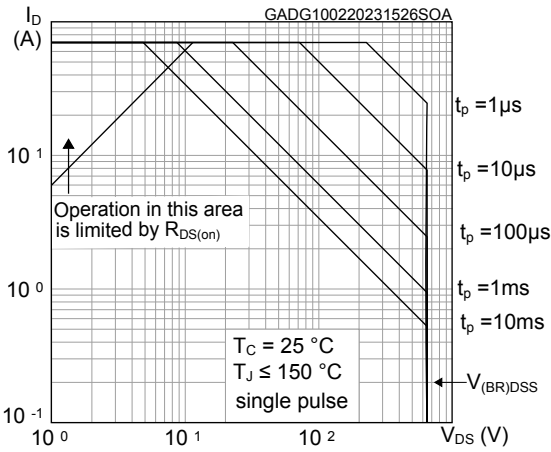
| Symbol       | Parameter                 | Test conditions  | Min.  | Typ. | Max. | Unit          |
|--------------|---------------------------|--|---|------|------|---------------|
| $t_{d(on)}$  | Turn-on delay time        | $V_{DS} = 400\text{ V}$ , $I_D = 15\text{ A}$ , $V_{GS} = 0\text{ to }6\text{ V}$ ,  | -   | 4.5  | -    | ns            |
| $t_f$        | Fall time                 | $R_{G(on)} = 10\ \Omega$ , $R_{G(off)} = 2.2\ \Omega$ , $L = 500\ \mu\text{H}$<br>(see Figure 20. Test circuit for inductive load switching times and Figure 21. Switching time waveforms) | -   | 5.6  | -    | ns            |
| $t_{d(off)}$ | Turn-off delay time       |  | -   | 9.8  | -    | ns            |
| $t_r$        | Rise time                 |  | -   | 10.9 | -    | ns            |
| $t_{d(on)}$  | Turn-on delay time        |  | $V_{DS} = 400\text{ V}$ , $I_D = 15\text{ A}$ , $V_{GS} = 0\text{ to }6\text{ V}$ , | -    | 5.2  | -             |
| $t_f$        | Fall time                 | $R_{G(on)} = 10\ \Omega$ , $R_{G(off)} = 2.2\ \Omega$ , $L = 500\ \mu\text{H}$ ,   | -   | 5.3  | -    | ns            |
| $t_{d(off)}$ | Turn-off delay time       | $T_C = 150\text{ }^\circ\text{C}$<br>(see Figure 20. Test circuit for inductive load switching times and Figure 21. Switching time waveforms)  | -   | 10   | -    | ns            |
| $t_r$        | Rise time                 |  | -   | 12.5 | -    | ns            |
| $E_{on}$     | Turn-on switching energy  | $V_{DS} = 400\text{ V}$ , $I_D = 15\text{ A}$ , $V_{GS} = 0\text{ to }6\text{ V}$ ,  | -   | 33.8 | -    | $\mu\text{J}$ |
| $E_{off}$    | Turn-off switching energy | $R_{G(on)} = 10\ \Omega$ , $R_{G(off)} = 2.2\ \Omega$ , $L = 500\ \mu\text{H}$   | -   | 19.5 | -    | $\mu\text{J}$ |

**Table 6. Reverse conduction**

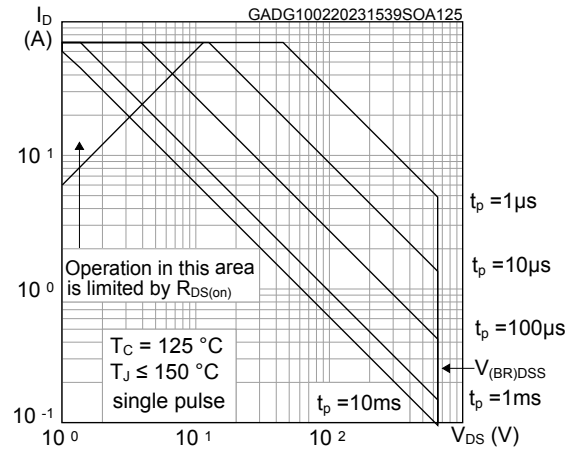
| Symbol   | Parameter                    | Test conditions                                | Min. | Typ. | Max. | Unit |
|----------|------------------------------|--|------|------|------|------|
| $V_{SD}$ | Source-drain reverse voltage | $V_{GS} = 0\text{ V}$ , $I_{SD} = 15\text{ A}$ | -    | 3.3  | -    | V    |

## 2.1 Electrical characteristics (curves)

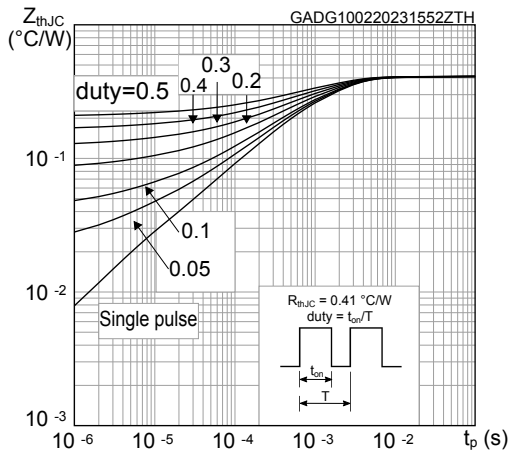
**Figure 1. Safe operating area ( $T_C = 25\text{ }^\circ\text{C}$ )**



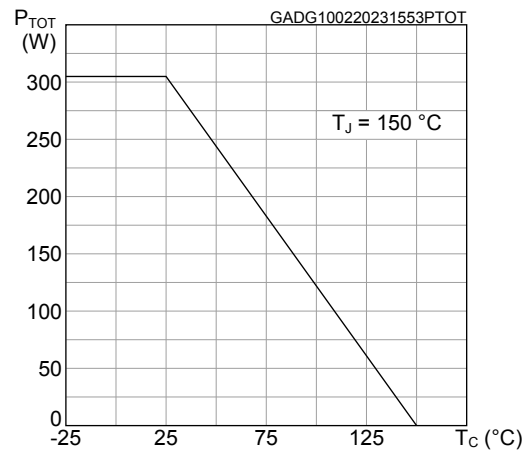
**Figure 2. Safe operating area ( $T_C = 125\text{ }^\circ\text{C}$ )**



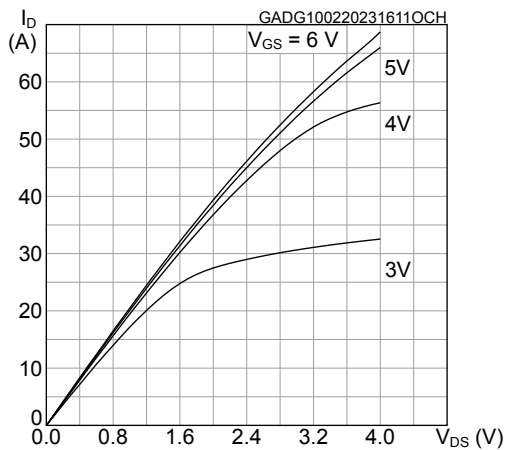
**Figure 3. Maximum transient thermal impedance**



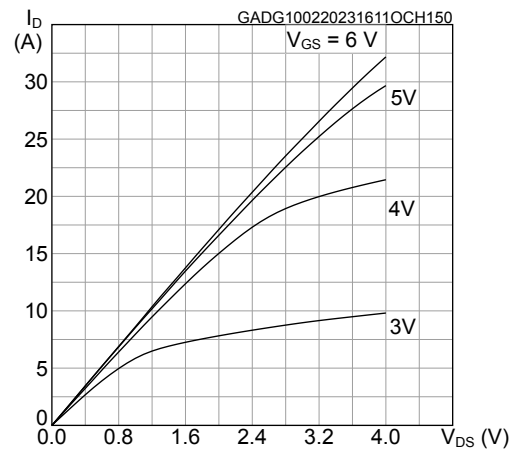
**Figure 4. Total power dissipation**



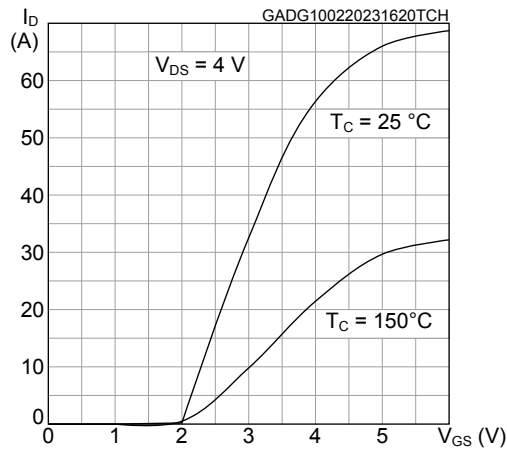
**Figure 5. Typical output characteristics ( $T_C = 25\text{ }^\circ\text{C}$ )**



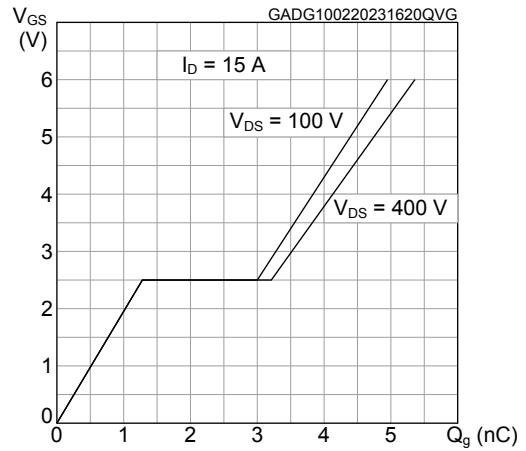
**Figure 6. Typical output characteristics ( $T_C = 150\text{ }^\circ\text{C}$ )**



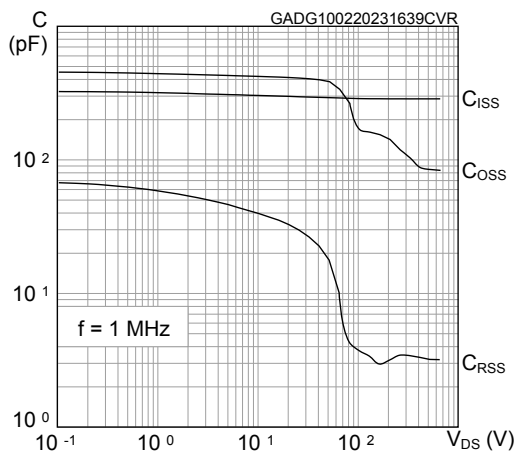
**Figure 7. Typical transfer characteristics**



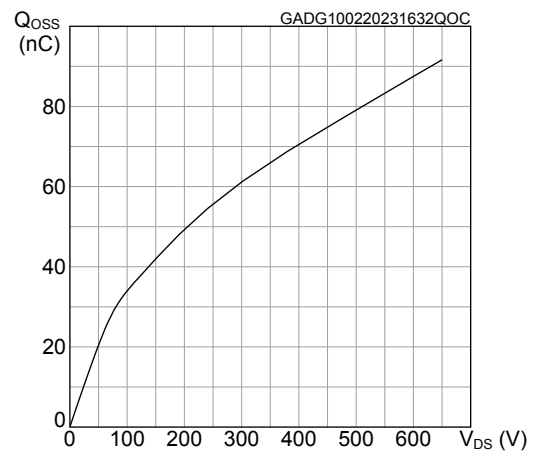
**Figure 8. Typical gate charge characteristics**



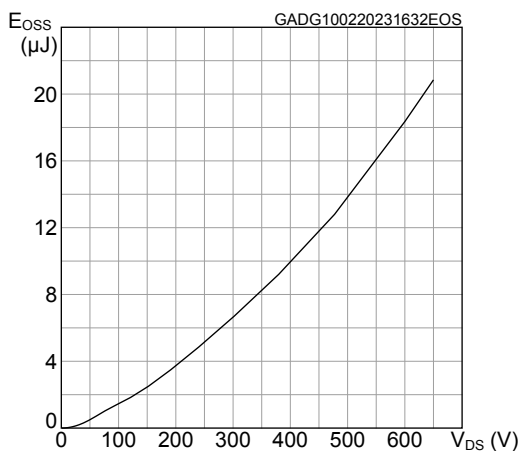
**Figure 9. Typical capacitance characteristics**



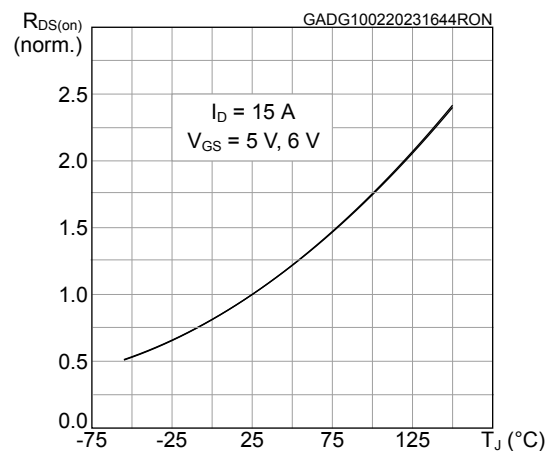
**Figure 10. Typical output charge**



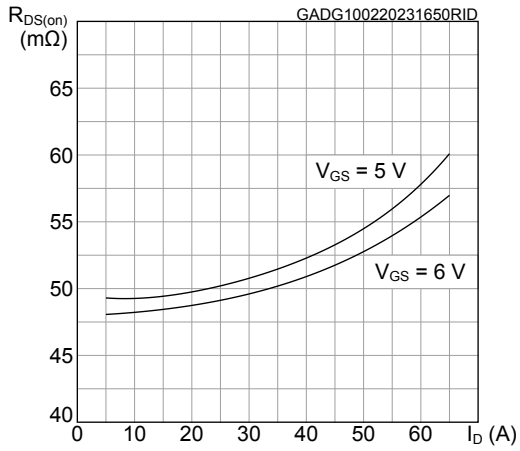
**Figure 11. Typical output capacitance stored energy**



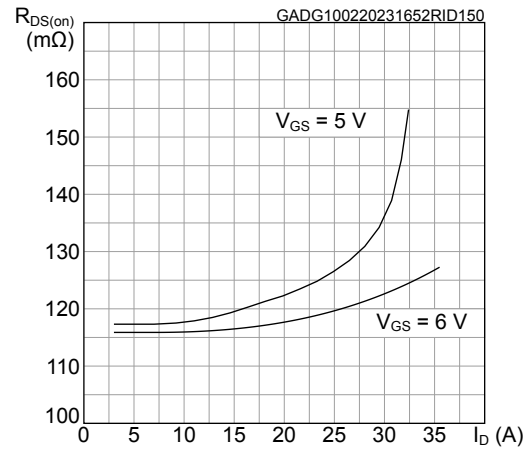
**Figure 12. Normalized on-resistance vs temperature**



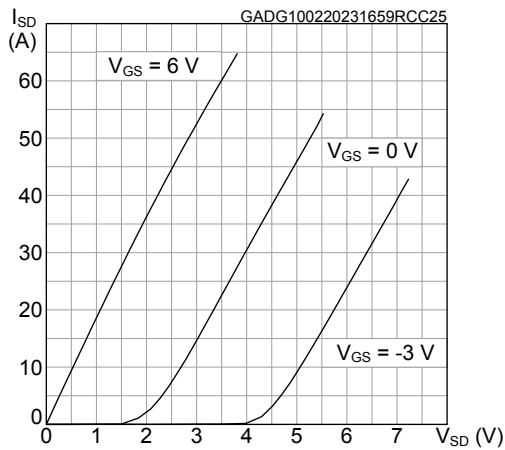
**Figure 13. Typical drain-source on-resistance ( $T_C = 25\text{ }^\circ\text{C}$ )**



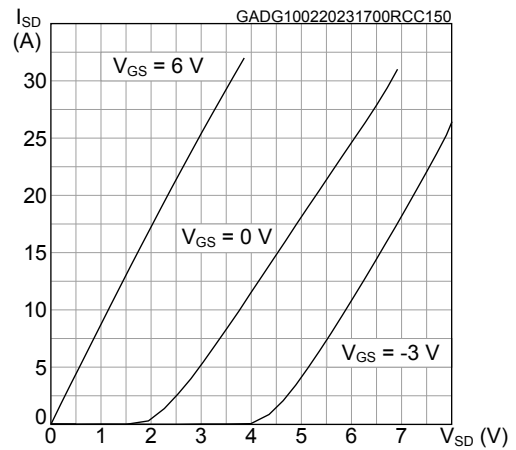
**Figure 14. Typical drain-source on-resistance ( $T_C = 150\text{ }^\circ\text{C}$ )**



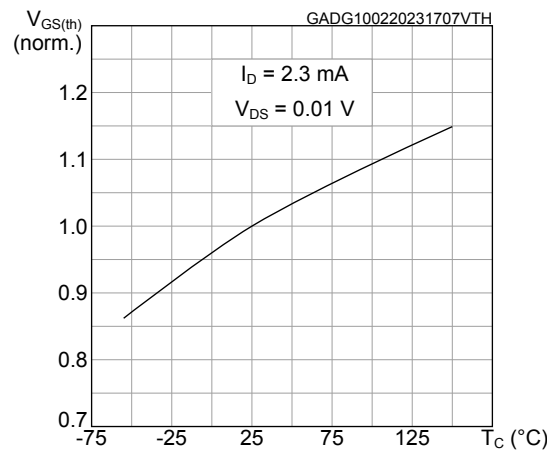
**Figure 15. Typical reverse conduction characteristics ( $T_C = 25\text{ }^\circ\text{C}$ )**



**Figure 16. Typical reverse conduction characteristics ( $T_C = 150\text{ }^\circ\text{C}$ )**

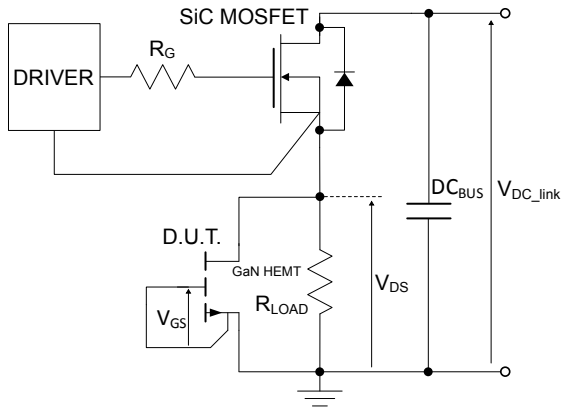


**Figure 17. Normalized gate threshold vs temperature**



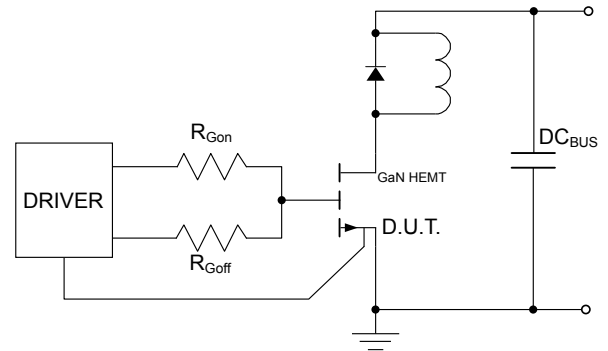
### 3 Test circuits

Figure 18. Test circuit for transient drain-source voltage



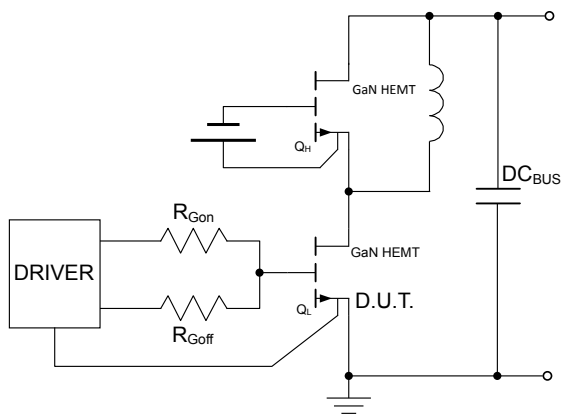
GADG031220211521GT

Figure 19. Test circuit for gate charge behavior



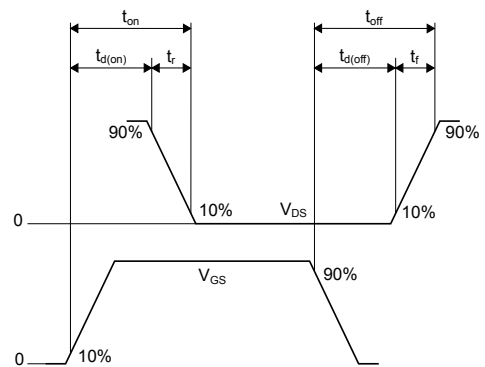
GADG270820210906SA

Figure 20. Test circuit for inductive load switching times



GADG270820210909SA

Figure 21. Switching time waveforms



AM01473v1

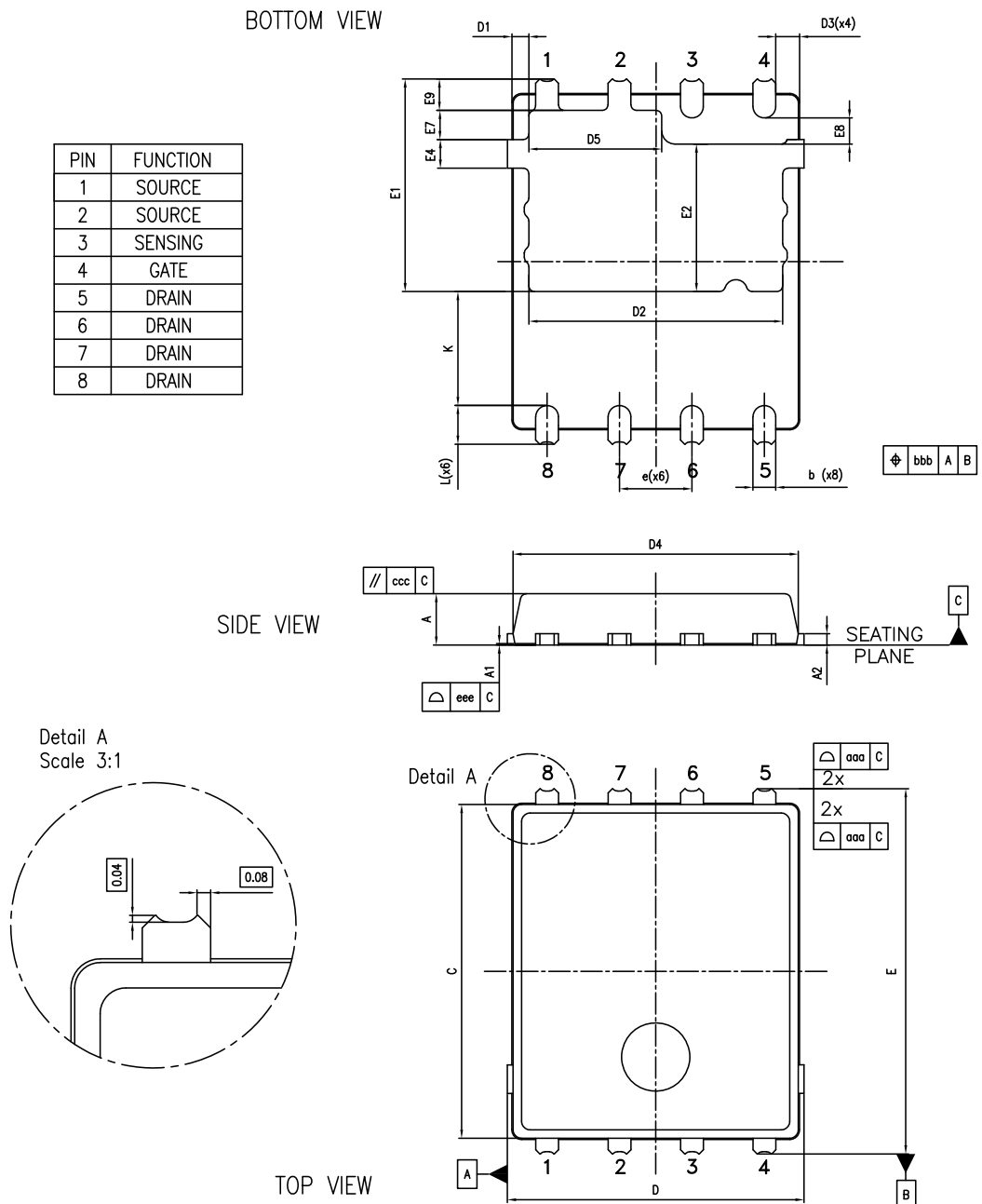


## 4 Package information

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 PowerFLAT 5x6 HV for PowerGaN package information

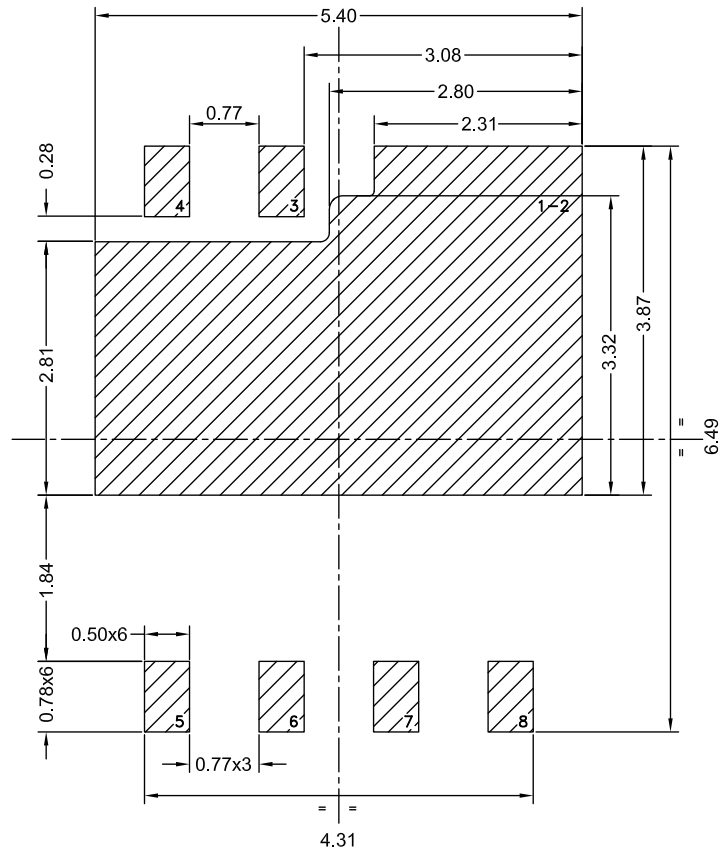
Figure 22. PowerFLAT 5x6 HV for PowerGaN package outline



**Table 7. PowerFLAT 5x6 HV for PowerGaN mechanical data**

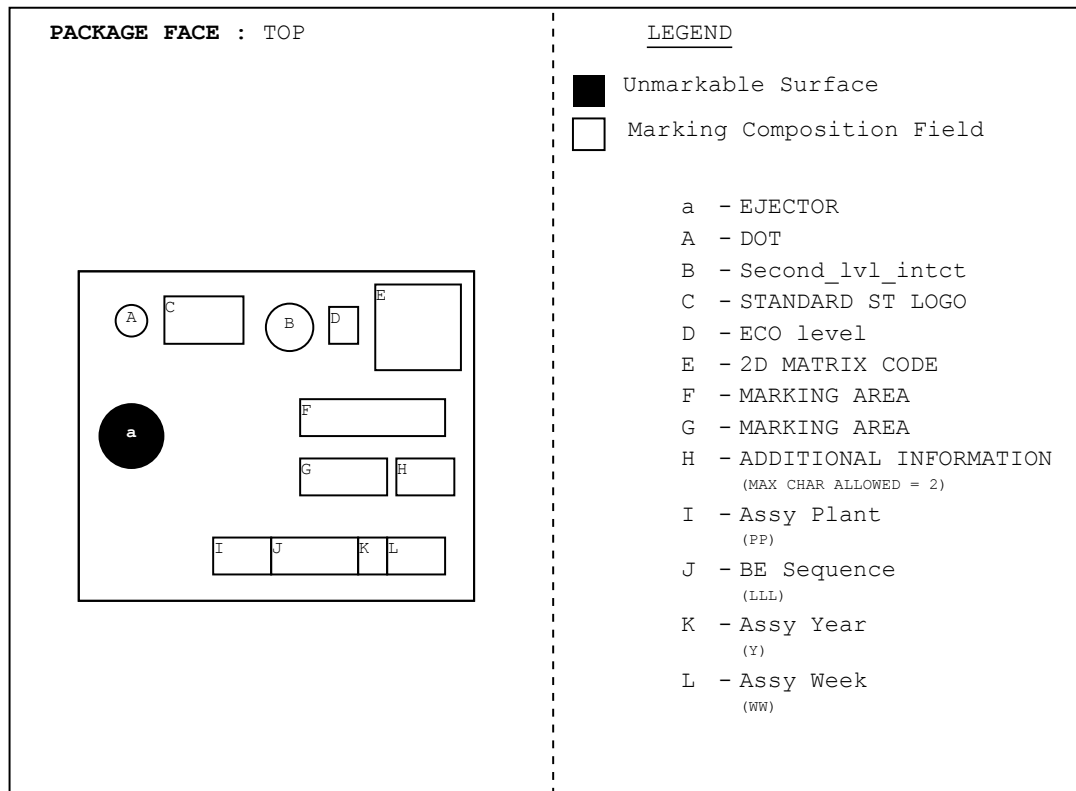
| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 0.80 | 0.95 | 1.00 |
| A1   |      |      | 0.05 |
| A2   | 0.20 | 0.25 | 0.30 |
| b    | 0.30 |      | 0.50 |
| C    | 5.65 | 5.85 | 6.05 |
| D    | 5.10 | 5.20 | 5.30 |
| D1   | 0.15 | 0.30 | 0.45 |
| D2   | 4.30 | 4.40 | 4.50 |
| D3   | 0.25 | 0.40 | 0.55 |
| D4   | 4.80 | 5.00 | 5.20 |
| D5   | 2.23 | 2.33 | 2.43 |
| E    | 6.20 | 6.40 | 6.60 |
| E1   | 3.62 | 3.72 | 3.82 |
| E2   | 2.45 | 2.55 | 2.65 |
| E4   | 0.40 | 0.50 | 0.60 |
| E7   | 0.40 | 0.50 | 0.60 |
| E8   | 0.39 | 0.49 | 0.59 |
| E9   | 0.47 | 0.55 | 0.63 |
| e    |      | 1.27 |      |
| L    | 0.58 | 0.68 | 0.78 |
| K    | 1.90 | 2.00 | 2.10 |
| aaa  |      | 0.15 |      |
| bbb  |      | 0.15 |      |
| ccc  |      | 0.10 |      |
| eee  |      | 0.10 |      |

Figure 23. PowerFLAT 5x6 HV for PowerGaN recommended footprint (dimensions are in mm)



DM00649592\_Rev\_6\_footprint\_for\_GaN

**Figure 24. Marking composition for PowerFLAT 5x6 HV for PowerGaN**



GADG230220210901SA

**Engineering samples**

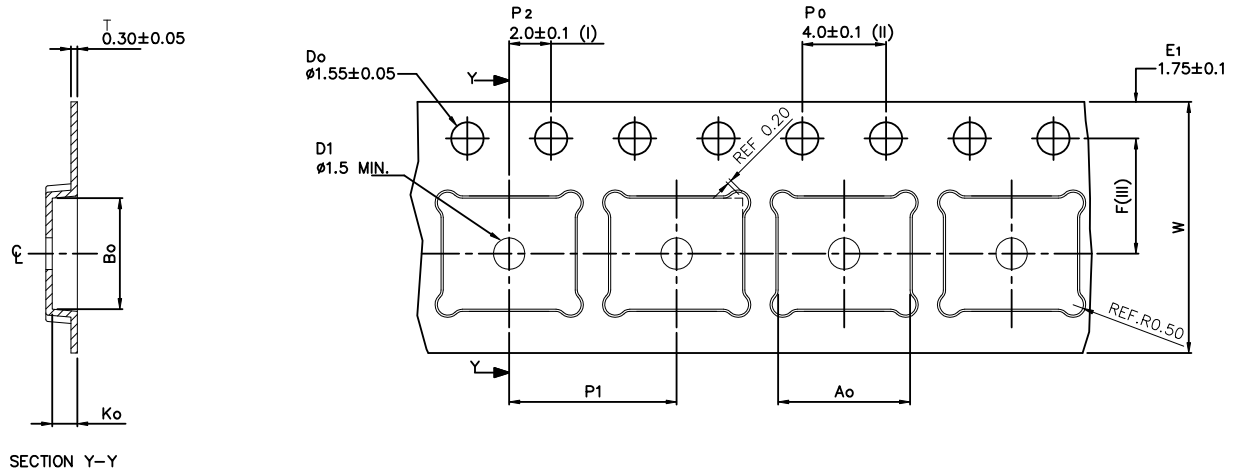
These samples are clearly identified by “ES” digits in the marking additional information field of each unit. These samples are intended to be used for electrical compatibility evaluation only; usage for any other purpose may be agreed only upon written authorization by ST. ST is not liable for any customer usage in production and/or in reliability qualification trials.

**Commercial samples**

Fully qualified parts from ST standard production with no limitations of use or special identification marking.

## 4.2 PowerFLAT 5x6 packing information

Figure 25. PowerFLAT 5x6 tape (dimensions are in mm)



|    |       |         |
|----|-------|---------|
| Ao | 6.30  | +/- 0.1 |
| B0 | 5.30  | +/- 0.1 |
| K0 | 1.20  | +/- 0.1 |
| F  | 5.50  | +/- 0.1 |
| P1 | 8.00  | +/- 0.1 |
| W  | 12.00 | +/- 0.3 |

(I) Measured from centreline of sprocket hole to centreline of pocket.

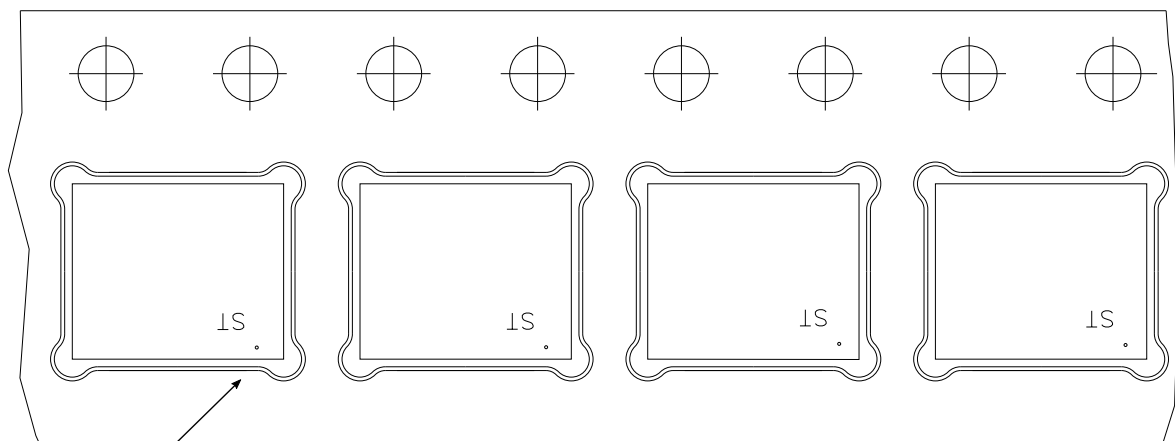
(II) Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$ .

(III) Measured from centreline of sprocket hole to centreline of pocket

Base and bulk quantity 3000 pcs  
All dimensions are in millimeters

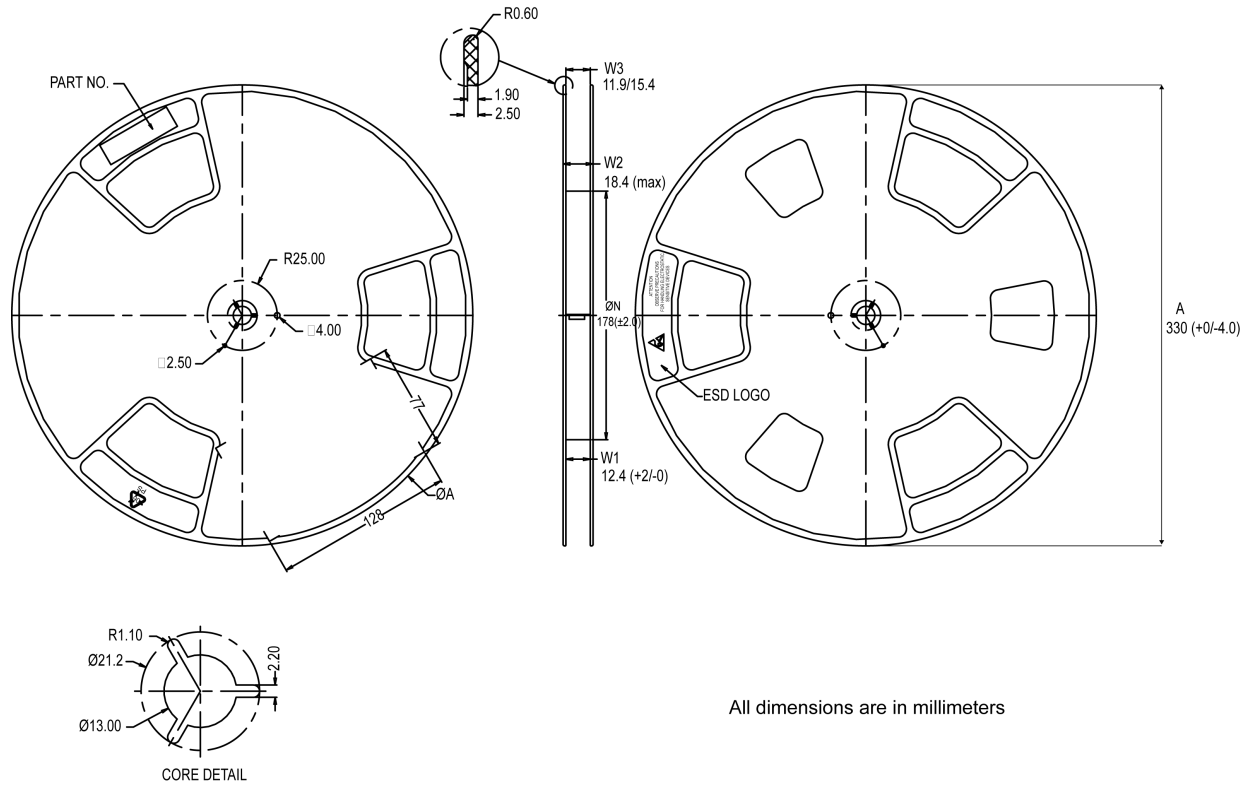
8234350\_Tape\_rev\_C

Figure 26. PowerFLAT 5x6 package orientation in carrier tape



Pin 1 identification

Figure 27. PowerFLAT 5x6 reel



All dimensions are in millimeters

8234350\_Reel\_rev\_C

## Revision history

**Table 8. Document revision history**

| Date        | Version | Changes   |
|-------------|---------|---|
| 07-Feb-2020 | 1       | First release.  |
| 14-Feb-2020 | 2       | Modified description on cover page.   |
| 30-Mar-2020 | 3       | Updated <i>Section 3 Package information</i> .  |
| 08-Jul-2020 | 4       | Updated <i>Section 3.1 PowerFLAT 5x6 HV for GaN package information</i> .<br>Minor text changes.  |
| 14-Dec-2022 | 5       | Updated <i>Features, Internal schematic, PowerFLAT 5x6 HV for PowerGaN cover image silhouette, Applications, Product status / summary and Description</i> in cover page.<br>Updated <i>Table 1. Absolute maximum ratings</i> .<br>Updated <i>Table 2. Thermal data</i> .<br>Updated <i>Table 3. Static</i> .<br>Inserted <i>Table 4. Dynamic</i> .<br>Inserted <i>Figure 3. Marking composition for PowerFLAT 5x6 HV for PowerGaN</i> .<br>Inserted <i>Section 3.2 PowerFLAT 5x6 packing information</i> .<br>Minor text changes. |
| 14-Feb-2023 | 6       | Updated title and <i>Features</i> in cover page.<br>Updated <i>Table 1. Absolute maximum ratings</i> .<br>Updated <i>Table 2. Thermal data</i> .<br>Updated <i>Table 3. Static</i> .<br>Updated <i>Table 4. Dynamic</i> .<br>Added <i>Table 5. Switching times</i> and <i>Table 6. Reverse conduction</i> .<br>Added <i>Section 2.1 Electrical characteristics (curves)</i> .<br>Added <i>Section 3 Test circuits</i> .<br>Updated <i>Figure 24. Marking composition for PowerFLAT 5x6 HV for PowerGaN</i> .                      |
| 23-Mar-2023 | 7       | Updated <i>Table 1. Absolute maximum ratings</i> .  |
| 11-Sep-2023 | 8       | Updated <i>Table 3. Static</i> .  |

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| <b>3</b>   | <b>Test circuits</b> .....                              | <b>8</b>  |
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| <b>4.1</b> | PowerFLAT 5x6 HV for PowerGaN package information ..... | <b>9</b>  |
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