

## Automotive-grade N-channel 40 V, 3.0 mΩ typ., 55 A STripFET™ F6 Power MOSFET in a PowerFLAT™ 5x6 package

Datasheet - production data

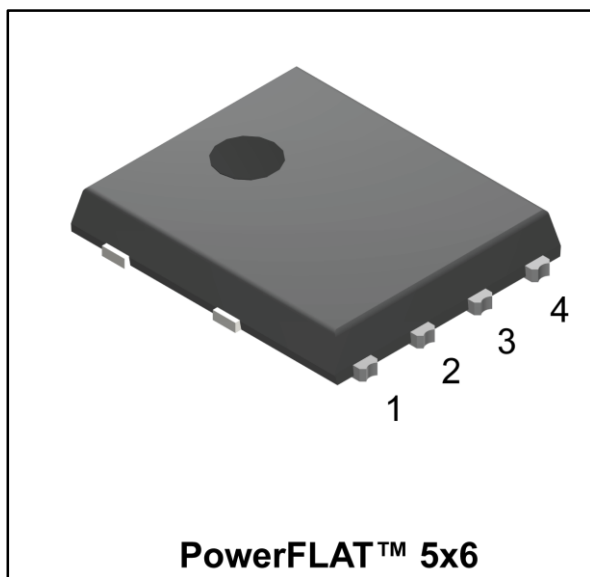
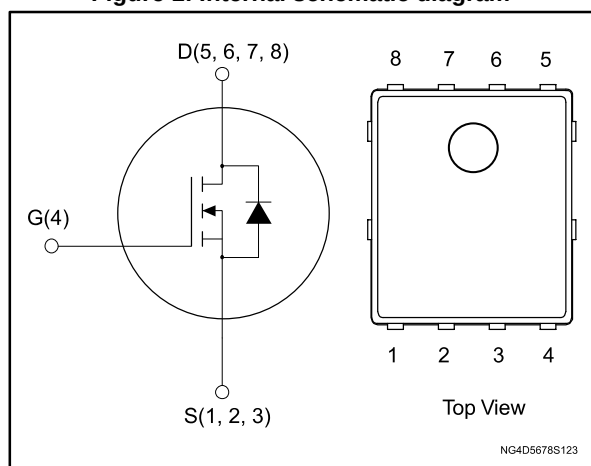


Figure 1: Internal schematic diagram



### Features

| Order code    | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | P <sub>TOT</sub> |
|---------------|-----------------|--------------------------|----------------|------------------|
| STL120N4LF6AG | 40 V            | 3.6 mΩ                   | 55 A           | 96 W             |

- Designed for automotive applications and AEC-Q101 qualified
- Very low on-resistance
- Very low gate charge
- High avalanche ruggedness
- Low gate drive power loss
- Wettable flank package

### Applications

- Switching applications

### Description

This device is an N-channel Power MOSFET developed using the STripFET™ F6 technology with a new trench gate structure. The resulting Power MOSFET exhibits very low R<sub>DS(on)</sub> in all packages.

Table 1: Device summary

| Order code    | Marking  | Package        | Packing       |
|---------------|----------|----------------|---------------|
| STL120N4LF6AG | 120N4LF6 | PowerFLAT™ 5x6 | Tape and reel |

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## Contents

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol         | Parameter                                                         | Value       | Unit               |
|----------------|-------------------------------------------------------------------|-------------|--------------------|
| $V_{GS}$       | Gate-source voltage                                               | 40          | V                  |
| $V_{DS}$       | Drain-source voltage                                              | $\pm 20$    | V                  |
| $I_D^{(1)}$    | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$  | 55          | A                  |
| $I_D^{(1)}$    | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 55          | A                  |
| $I_{DM}^{(2)}$ | Drain current (pulsed)                                            | 220         | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 96          | W                  |
| $T_{stg}$      | Storage temperature range                                         | - 55 to 175 | $^{\circ}\text{C}$ |
| $T_j$          | Operating junction temperature range                              |             | $^{\circ}\text{C}$ |

**Notes:**

<sup>(1)</sup> Drain current is limited by package, the current capability of the silicon is 120 A at 25  $^{\circ}\text{C}$

<sup>(2)</sup> Pulse width is limited by safe operating area

Table 3: Thermal data

| Symbol              | Parameter                        | Value | Unit                 |
|---------------------|----------------------------------|-------|----------------------|
| $R_{thj-case}$      | Thermal resistance junction-case | 1.56  | $^{\circ}\text{C/W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  | 31.3  |                      |

**Notes:**

<sup>(1)</sup>When mounted on 1 inch<sup>2</sup> 2 Oz. Cu board,  $t \leq 10\text{ s}$

Table 4: Avalanche characteristics

| Symbol   | Parameter                                                                                                         | Value | Unit |
|----------|-------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AV}$ | Avalanche current, repetitive or not repetitive (pulse width limited by maximum junction temperature)             | 26    | A    |
| $E_{AS}$ | Single pulse avalanche energy<br>( $T_j = 25\text{ }^{\circ}\text{C}$ , $I_C = I_{AV}$ , $V_{DD} = 25\text{ V}$ ) | 200   | mJ   |

## 2 Electrical characteristics

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

Table 5: 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 V, I <sub>D</sub> = 250 μA                                        | 40   |      |      | V    |
| I <sub>DSS</sub>     | Zero gate voltage Drain current   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 40 V                                         |      |      | 1    | μA   |
|                      |                                   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 40 V, T <sub>J</sub> = 125 °C <sup>(1)</sup> |      |      | 10   | μA   |
| I <sub>GSS</sub>     | Gate-body leakage current         | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±20 V                                        |      |      | ±100 | nA   |
| V <sub>GS(th)</sub>  | Gate threshold voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                           | 1    |      | 3    | V    |
| R <sub>DS(on)</sub>  | Static drain-source on-resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 13 A                                         |      | 3.0  | 3.6  | mΩ   |
|                      |                                   | V <sub>GS</sub> = 5 V, I <sub>D</sub> = 13 A                                          |      | 3.2  | 4.5  |      |

**Notes:**

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

Table 6: Dynamic

| Symbol           | Parameter                    | Test conditions                                                                                                                                    | Min. | Typ. | Max. | Unit |
|------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| C <sub>iss</sub> | Input capacitance            | V <sub>DS</sub> = 25 V, f = 1 MHz, V <sub>GS</sub> = 0 V                                                                                           | -    | 4260 | -    | pF   |
| C <sub>oss</sub> | Output capacitance           |                                                                                                                                                    | -    | 647  | -    |      |
| C <sub>rss</sub> | Reverse transfer capacitance |                                                                                                                                                    | -    | 373  | -    |      |
| Q <sub>g</sub>   | Total gate charge            | V <sub>DD</sub> = 20 V, I <sub>D</sub> = 26 A, V <sub>GS</sub> = 10 V<br>(see <a href="#">Figure 14: "Test circuit for gate charge behavior"</a> ) | -    | 80   | -    | nC   |
| Q <sub>gs</sub>  | Gate-source charge           |                                                                                                                                                    | -    | 15   | -    |      |
| Q <sub>gd</sub>  | Gate-drain charge            |                                                                                                                                                    | -    | 15   | -    |      |
| R <sub>G</sub>   | Intrinsic gate resistance    | f = 1 MHz, I <sub>D</sub> = 0 A                                                                                                                    | -    | 1.5  | -    | Ω    |

Table 7: Switching times

| Symbol              | Parameter           | Test conditions                                                                                                                                                                                                                              | Min. | Typ. | Max. | Unit |
|---------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| t <sub>d(on)</sub>  | Turn-on delay time  | V <sub>DD</sub> = 20 V, I <sub>D</sub> = 13 A R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V<br>(see <a href="#">Figure 13: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 18: "Switching time waveform"</a> ) | -    | 20   | -    | ns   |
| t <sub>r</sub>      | Rise time           |                                                                                                                                                                                                                                              | -    | 70   | -    |      |
| t <sub>d(off)</sub> | Turn-off delay time |                                                                                                                                                                                                                                              | -    | 40   | -    |      |
| t <sub>f</sub>      | Fall time           |                                                                                                                                                                                                                                              | -    | 20   | -    |      |

Table 8: Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}^{(1)}$  | Source-drain current          |                                                                                                                                                                                                | -    |      | 26   | A    |
| $I_{SDM}^{(2)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                | -    |      | 104  | A    |
| $V_{SD}^{(3)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 13\text{ A}$                                                                                                                                                 | -    |      | 1.1  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 26\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 25\text{ V}$<br>(see <a href="#">Figure 15: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 40   |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                | -    | 5.6  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                | -    | 2.8  |      | A    |

**Notes:**

<sup>(1)</sup>This value is rated according to  $R_{thj-pcb}$

<sup>(2)</sup>Pulse width is limited by safe operating area

<sup>(3)</sup>Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

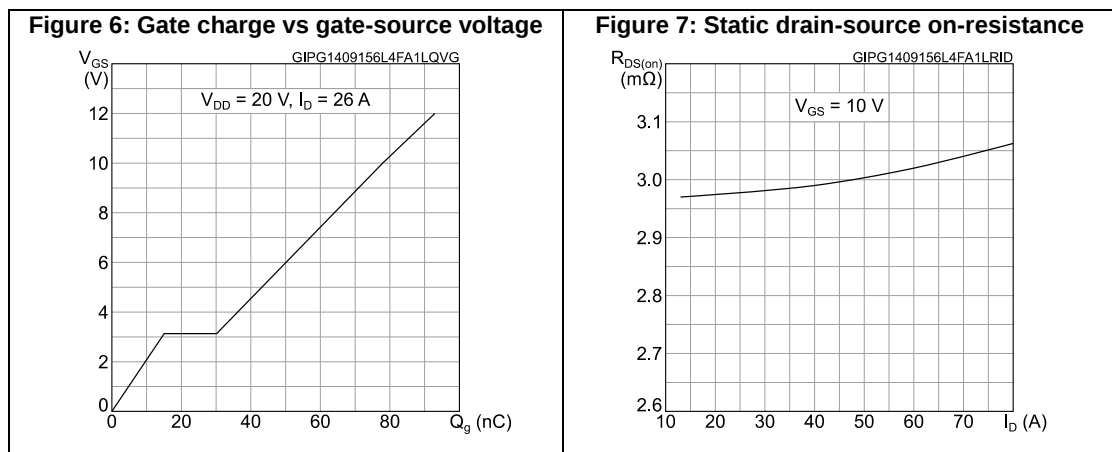
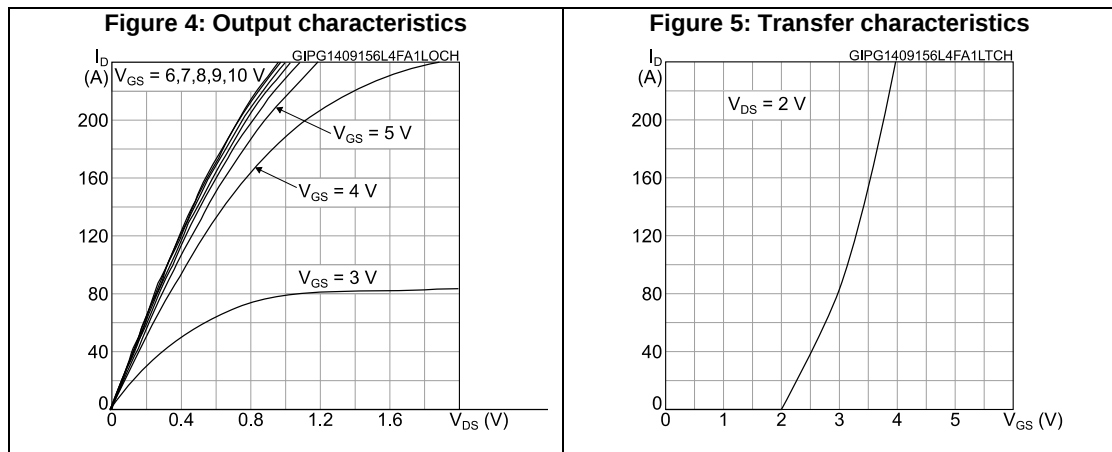
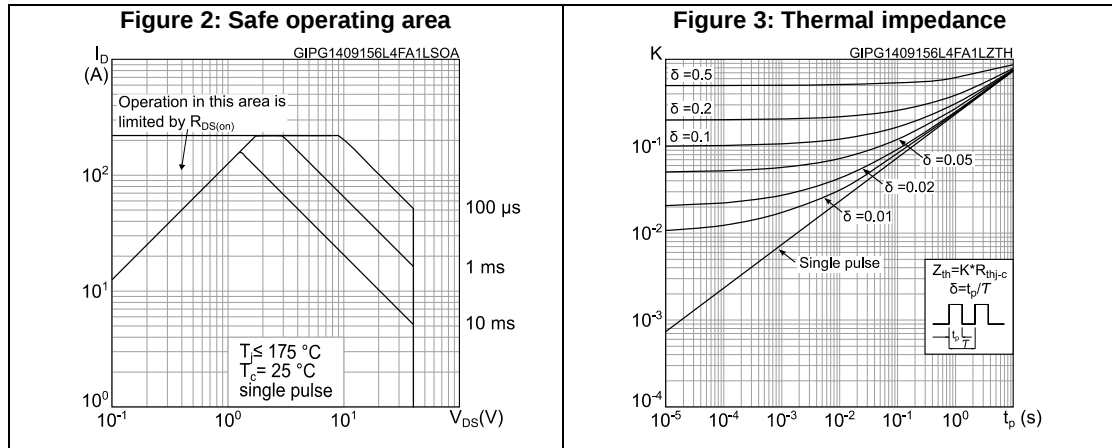


Figure 8: Capacitance variations

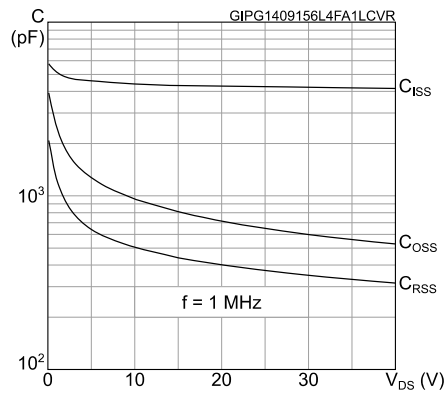


Figure 9: Normalized gate threshold voltage vs temperature

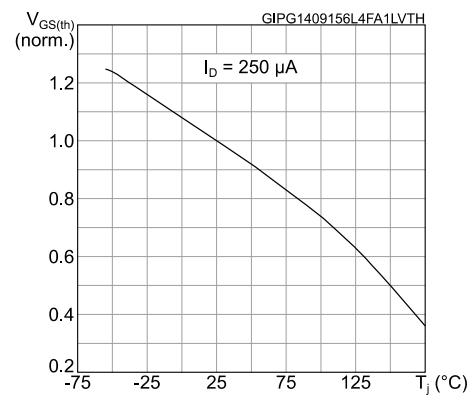


Figure 10: Normalized on-resistance vs temperature

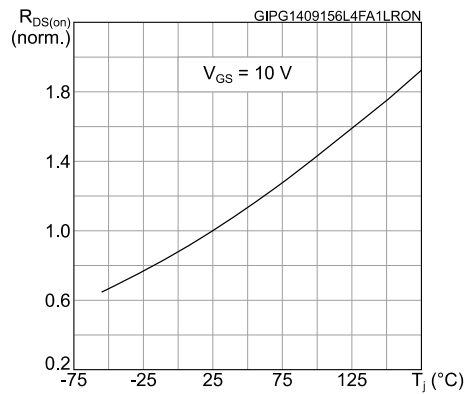
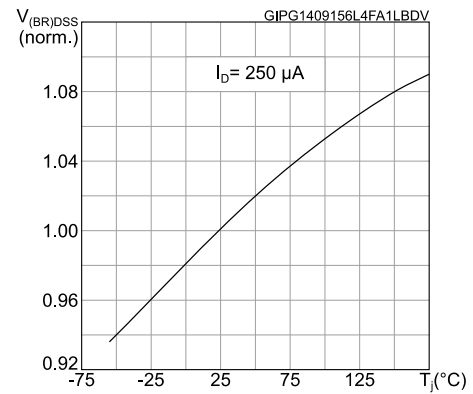
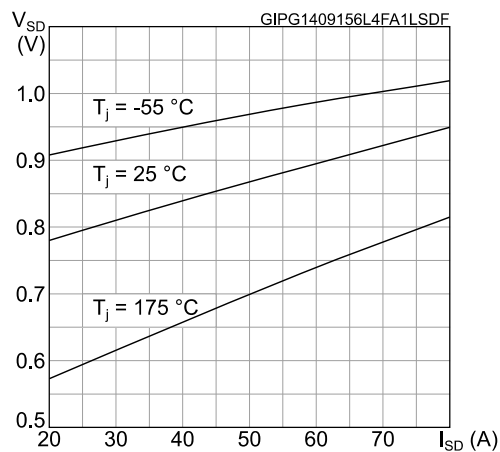
Figure 11: Normalized  $V_{(BR)DSS}$  vs temperature

Figure 12: Source-drain diode forward characteristics



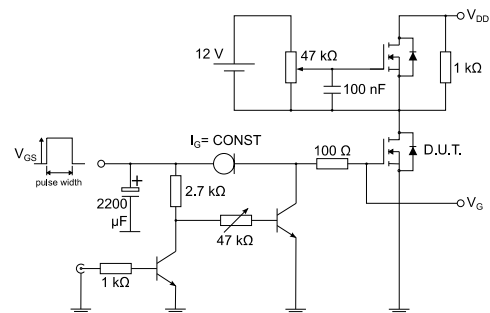
### 3 Test circuits

**Figure 13: Test circuit for resistive load switching times**



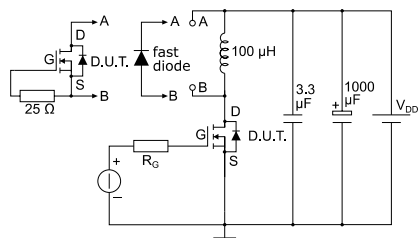
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**Figure 14: Test circuit for gate charge behavior**



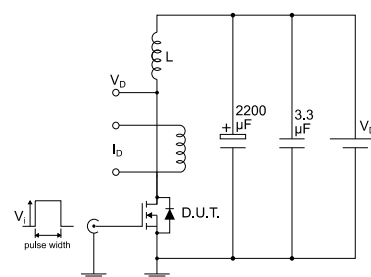
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**Figure 15: Test circuit for inductive load switching and diode recovery times**



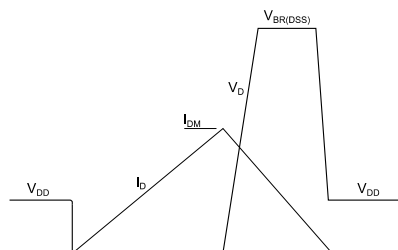
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**Figure 16: Unclamped inductive load test circuit**



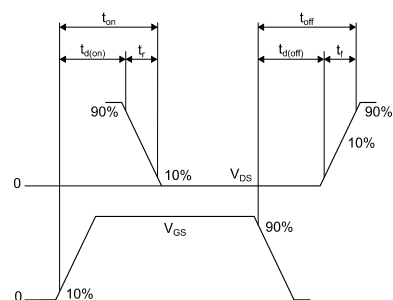
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**Figure 17: Unclamped inductive waveform**



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**Figure 18: Switching time waveform**



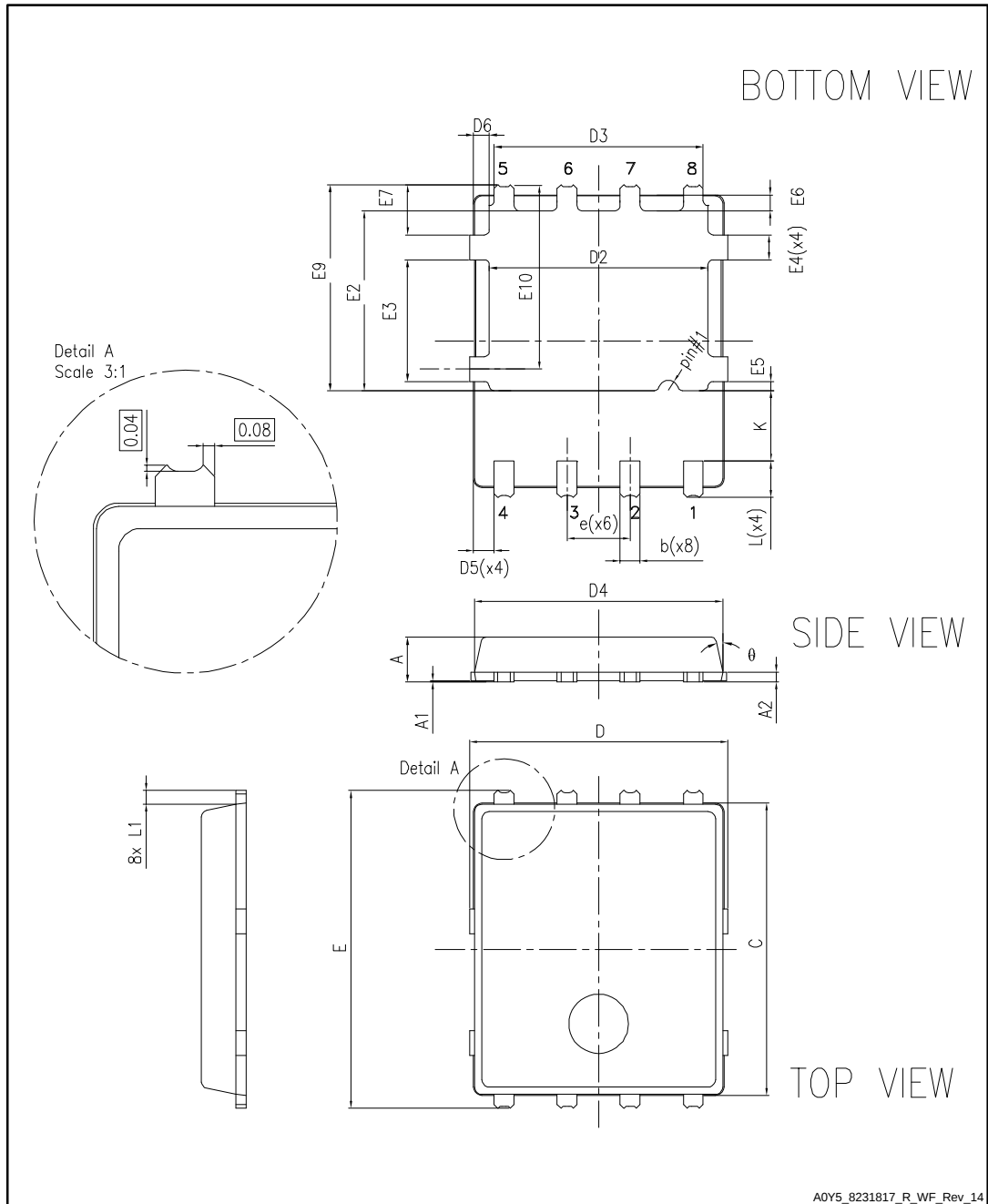
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## 4 Package information

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 PowerFLAT™ 5x6 WF type R package information

Figure 19: PowerFLAT™ 5x6 WF type R package outline

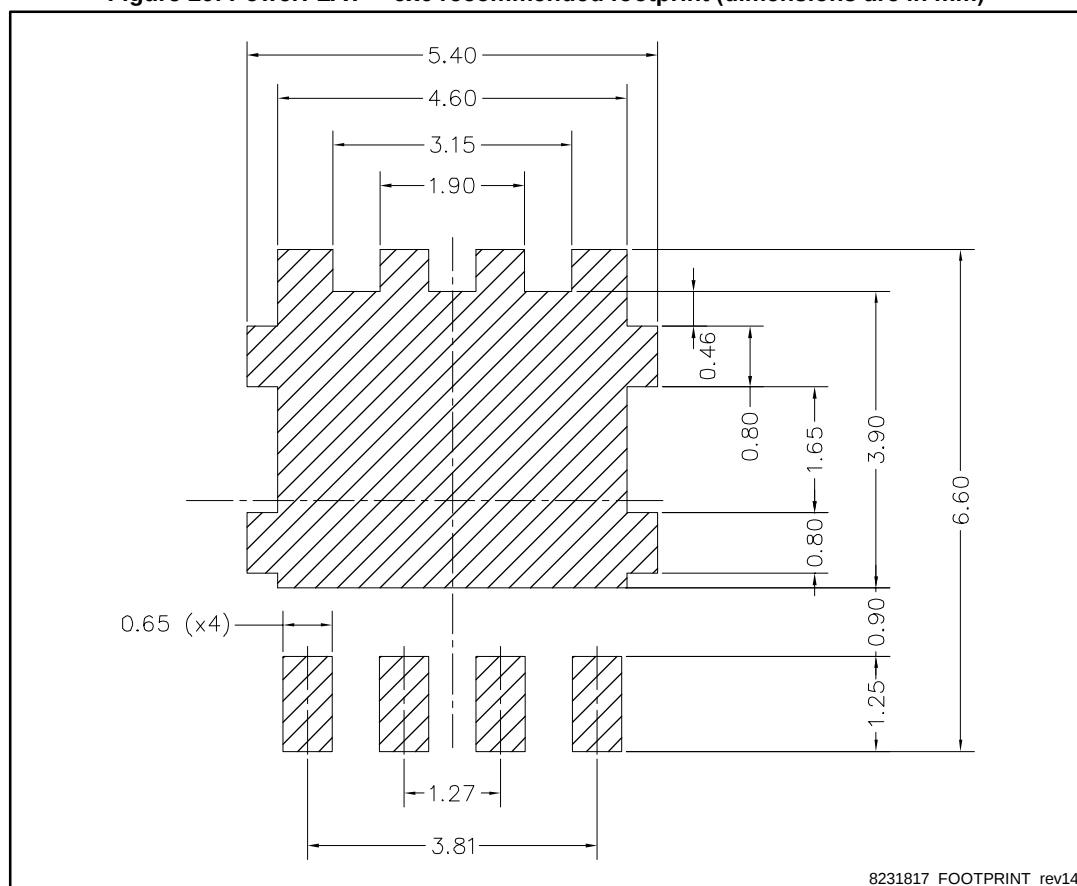


A0Y5\_8231817\_R\_WF\_Rev\_14

Table 9: PowerFLAT™ 5x6 WF type R mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 0.80  |       | 1.00  |
| A1   | 0.02  |       | 0.05  |
| A2   |       | 0.25  |       |
| b    | 0.30  |       | 0.50  |
| C    | 5.80  | 6.00  | 6.10  |
| D    | 5.00  | 5.20  | 5.40  |
| D2   | 4.15  |       | 4.45  |
| D3   | 4.05  | 4.20  | 4.35  |
| D4   | 4.80  | 5.00  | 5.10  |
| D5   | 0.25  | 0.4   | 0.55  |
| D6   | 0.15  | 0.3   | 0.45  |
| e    |       | 1.27  |       |
| E    | 6.20  | 6.40  | 6.60  |
| E2   | 3.50  |       | 3.70  |
| E3   | 2.35  |       | 2.55  |
| E4   | 0.40  |       | 0.60  |
| E5   | 0.08  |       | 0.28  |
| E6   | 0.20  | 0.325 | 0.45  |
| E7   | 0.85  | 1.00  | 1.15  |
| E9   | 4.00  | 4.20  | 4.40  |
| E10  | 3.55  | 3.70  | 3.85  |
| K    | 1.275 |       | 1.575 |
| L    | 0.725 | 0.825 | 0.925 |
| L1   | 0.175 | 0.275 | 0.375 |
| Θ    | 0°    |       | 12°   |

Figure 20: PowerFLAT™ 5x6 recommended footprint (dimensions are in mm)



## 4.2 PowerFLAT™ 5x6 WF packing information

Figure 21: PowerFLAT™ 5x6 WF tape (dimensions are in mm)

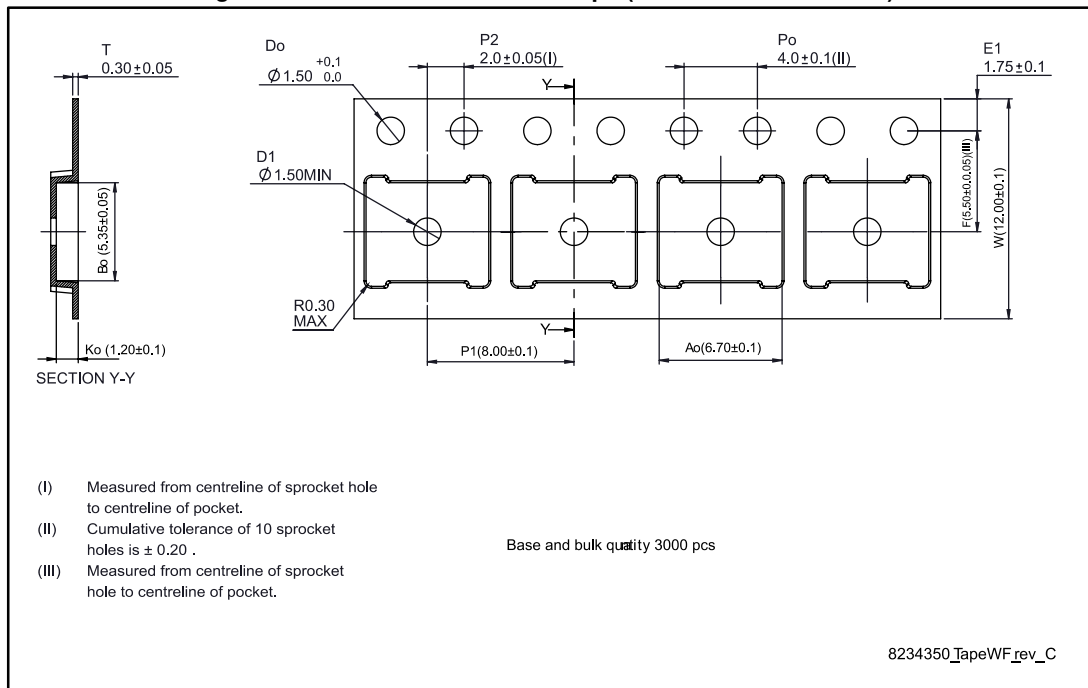


Figure 22: PowerFLAT™ 5x6 package orientation in carrier tape

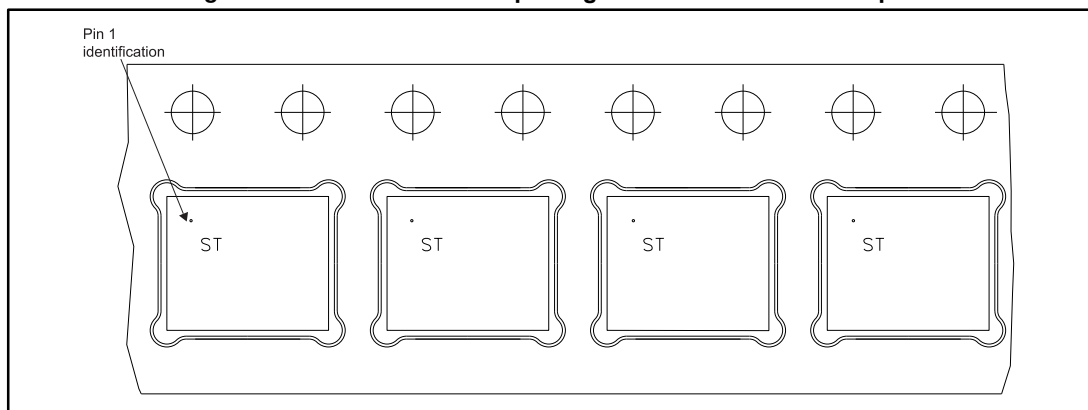
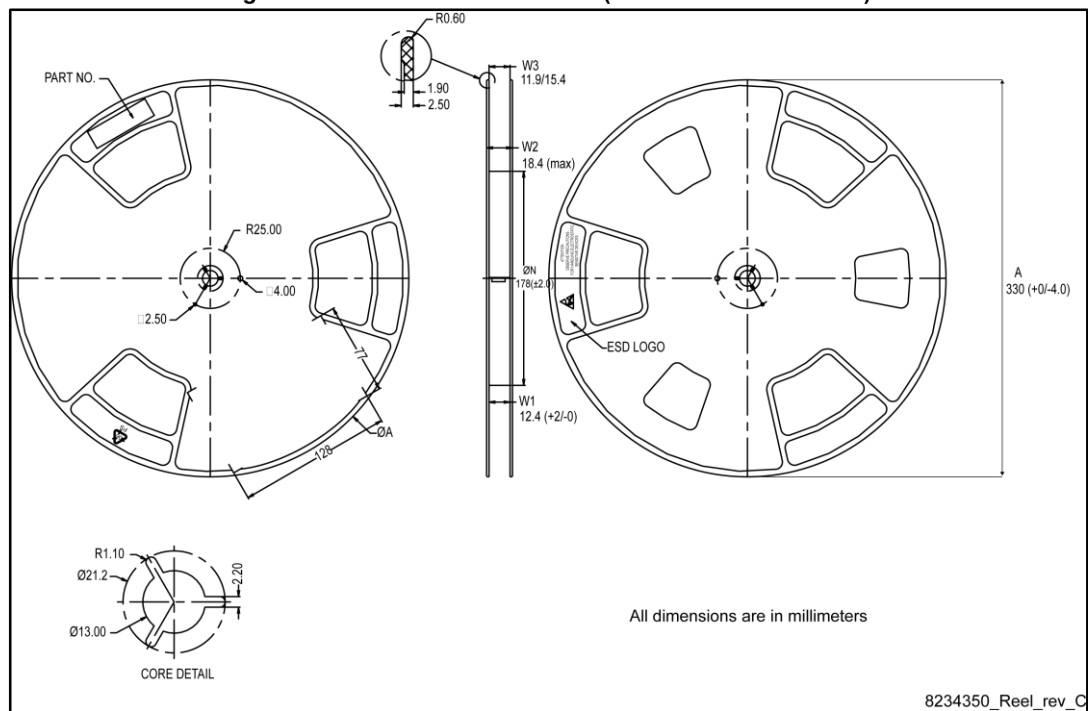


Figure 23: PowerFLAT™ 5x6 reel (dimensions are in mm)



## 5 Revision history

Table 10: Document revision history

| Date        | Revision | Changes                                                                                                                                                                                      |
|-------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25-Sep-2015 | 1        | First release.                                                                                                                                                                               |
| 15-Apr-2016 | 2        | Updated title, description and features in cover page .<br>Updated <a href="#">Table 2: "Absolute maximum ratings"</a> and <a href="#">Table 5: "On/off states"</a> .<br>Minor text changes. |

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