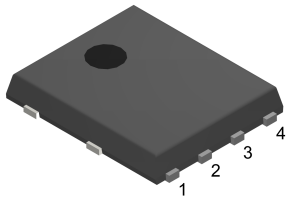
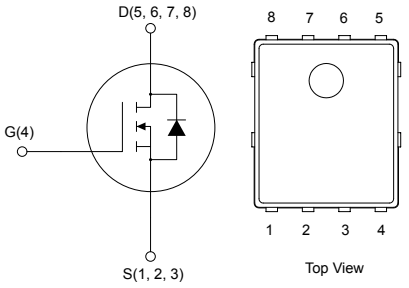
# N-channel 100 V, 14.5 mΩ typ., 12 A, STripFET F7 DeepGATE Power MOSFET in a PowerFLAT 5x6 package




**PowerFLAT 5x6**




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ | $P_{TOT}$ |
|---|---|---|---|---|
| STL60N10F7 | 100 V | 18 mΩ | 12 A | 5 W |

- Among the lowest $R_{DS(on)}$ on the market
- Excellent FoM (figure of merit)
- Low $C_{rss}/C_{iss}$ ratio for EMI immunity
- High avalanche ruggedness

## Applications

- Switching applications

## Description

This N-channel Power MOSFET utilizes STripFET F7 technology with an enhanced trench gate structure that results in very low on-state resistance, while also reducing internal capacitance and gate charge for faster and more efficient switching.

| Product status link |
|---|
| STL60N10F7 |

| Product summary | |
|---|---|
| **Order code** | STL60N10F7 |
| **Marking** | 60N10F7 |
| **Package** | PowerFLAT 5x6 |
| **Packing** | Tape and reel |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source voltage | 100 | V |
| $V_{GS}$ | Gate-source voltage | 20 | V |
| $I_D$(1) | Drain current (continuous) at $T_C$ = 25 °C | 46 | A |
| | Drain current (continuous) at $T_C$= 100 °C | 33 | A |
| $I_D$(2) | Drain current (continuous) at $T_{pcb}$ = 25 °C | 12 | A |
| | Drain current (continuous) at $T_{pcb}$= 100 °C | 9 | A |
| $I_{DM}$(2)(3) | Drain current (pulsed) | 48 | A |
| $P_{TOT}$(1) | Total power dissipation at $T_C$ = 25 °C | 72 | W |
| $P_{TOT}$(2) | Total power dissipation at $T_{pcb}$ = 25 °C | 5 | W |
| $T_{stg}$ | Storage temperature range | - 55 to 175 | °C |
| $T_J$ | Operating junction temperature range | | °C |

1. *This value is rated according to $R_{thj\text{-}c}$.*
2. *This value is rated according to $R_{thj\text{-}pcb}$.*
3. *Pulse width is limited by safe operating area.*

**Table 2. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case | 2.08 | °C/W |
| $R_{thj\text{-}pcb}$(1) | Thermal resistance junction-pcb | 31 | |

1. *When mounted on a 1-inch² FR-4 board, 2oz Cu, t < 10 s.*

# 2 Electrical characteristics

($T_C$ = 25 °C unless otherwise specified)

**Table 3. On/off states**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 100 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 100 V | | | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 100 V, $T_C$ = 125 °C | | | 100 | µA |
| $I_{GSS}$ | Gate-body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = 20 V | | | 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 2.5 | | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 6 A | | 14.5 | 18 | mΩ |

**Table 4. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ = 50 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 1640 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 360 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 25 | - | pF |
| $Q_g$ | Total gate charge | $V_{DD}$ = 50 V, $I_D$ = 12 A, $V_{GS}$ = 10 V (see Figure 13. Test circuit for gate charge behavior) | - | 25 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 12 | - | nC |
| $Q_{gd}$ | Gate-drain charge | | - | 5 | - | nC |
| $Q_{oss}$ | Output charge | $V_{DD}$ = 40 V, $V_{GS}$ = 0 V | - | 28 | - | nC |

**Table 5. Switching times**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 50 V, $I_D$ = 6 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see Figure 12. Test circuit for resistive load switching times and Figure 17. Switching time waveform) | - | 15 | - | ns |
| $t_r$ | Rise time | | - | 17 | - | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 24 | - | ns |
| $t_f$ | Fall time | | - | 8 | - | ns |

**Table 6. Source-drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 12 | A |
| $I_{SDM}$ (1) | Source-drain current (pulsed) | | - | | 48 | A |
| $V_{SD}$ (2) | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 16 A | - | | 1.1 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 12 A, di/dt = 100 A/µs, | - | 53 | | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_{DD}$ = 50 V, $T_J$ = 150 °C | - | 67 | | nC |
| $I_{RRM}$ | Reverse recovery current | (see Figure 14. Test circuit for inductive load switching and diode recovery times) | - | 2.5 | | A |

1. *Pulse width limited by safe operating area.*
2. *Pulse test: pulse duration = 300 µs, duty cycle 1.5%.*

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area**

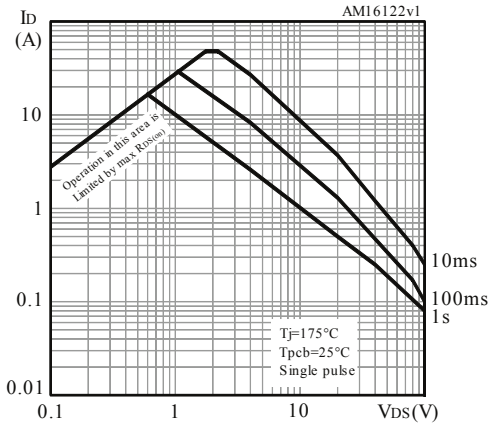



**Figure 2. Thermal impedance**

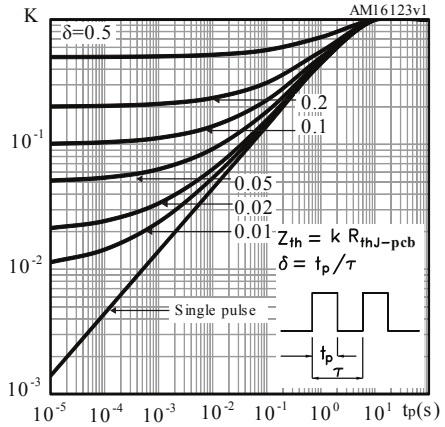



**Figure 3. Output characteristics**

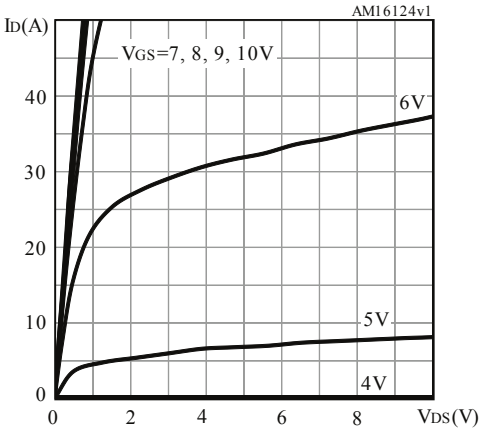



**Figure 4. Transfer characteristics**

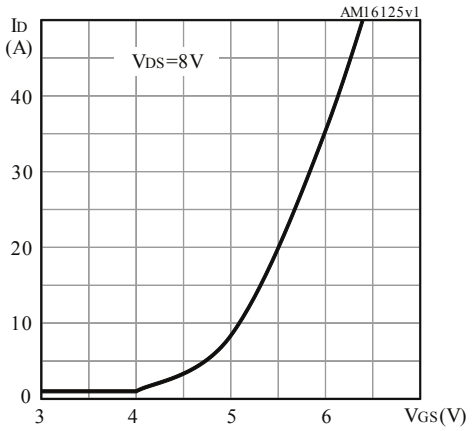



**Figure 5. Gate charge vs gate-source voltage**

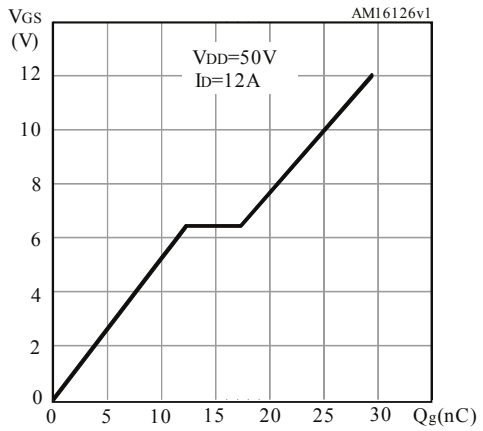



**Figure 6. Static drain-source on-resistance**

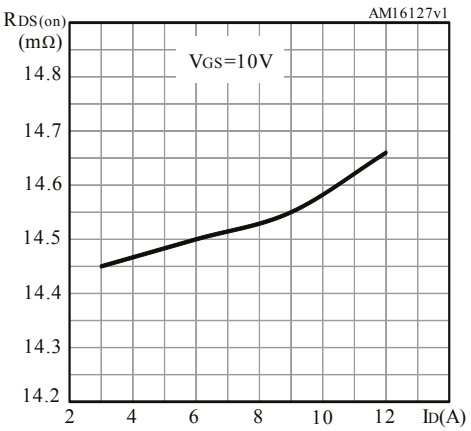


**Figure 7. Capacitance variations**

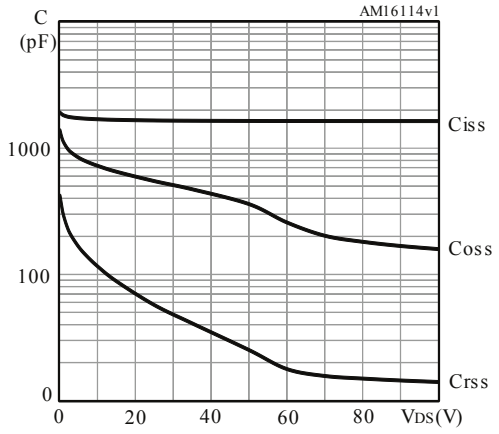



**Figure 8. Normalized gate threshold voltage vs temperature**

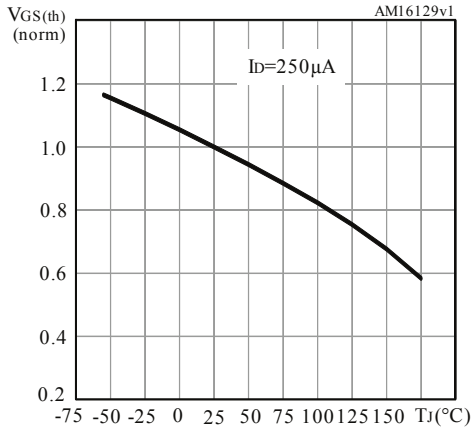



**Figure 9. Normalized on-resistance vs temperature**

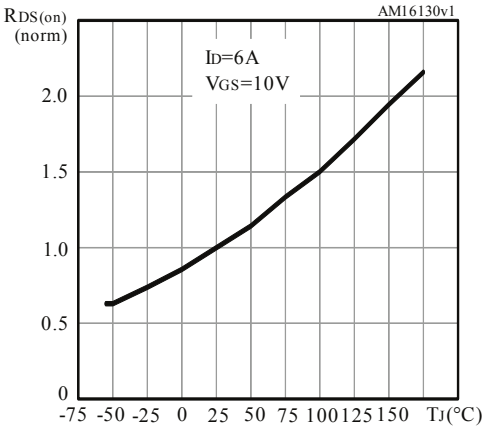



**Figure 10. Normalized $V_{(BR)DSS}$ vs temperature**

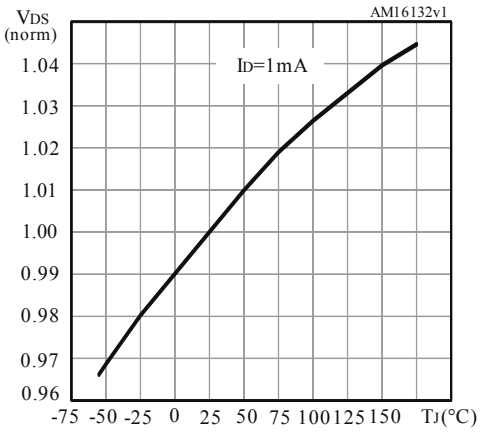
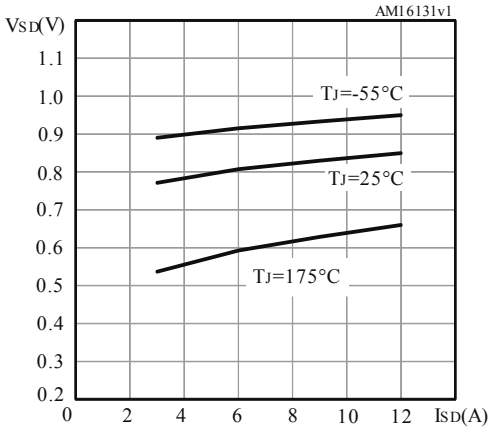



**Figure 11. Source-drain diode forward characteristics**



# 3 Test circuits

**Figure 12. Test circuit for resistive load switching times**

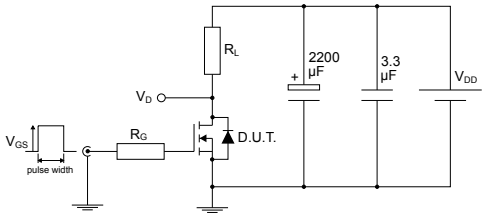



**Figure 13. Test circuit for gate charge behavior**

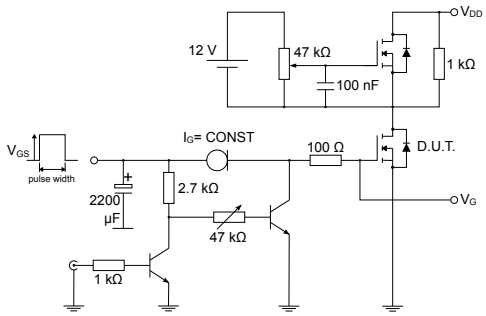



**Figure 14. Test circuit for inductive load switching and diode recovery times**

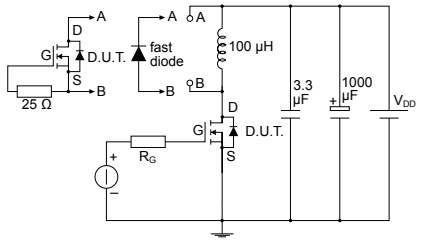



**Figure 15. Unclamped inductive load test circuit**

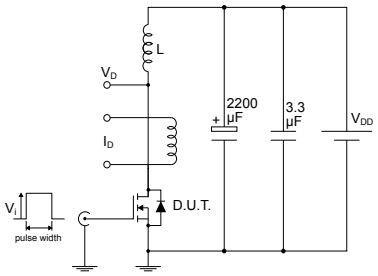



**Figure 16. Unclamped inductive waveform**

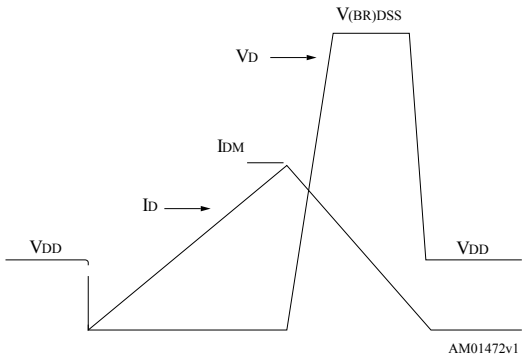
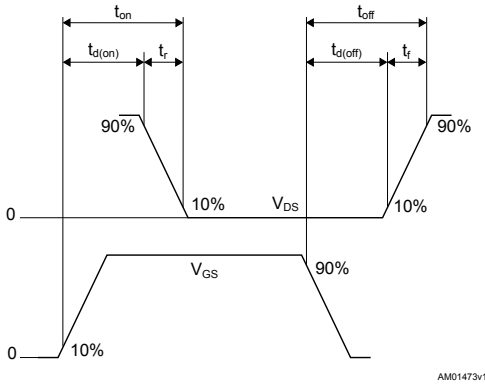



**Figure 17. Switching time waveform**



# 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. ECOPACK is an ST trademark.

## 4.1 PowerFLAT 5x6 type R package information

**Figure 18. PowerFLAT 5x6 type R package outline**

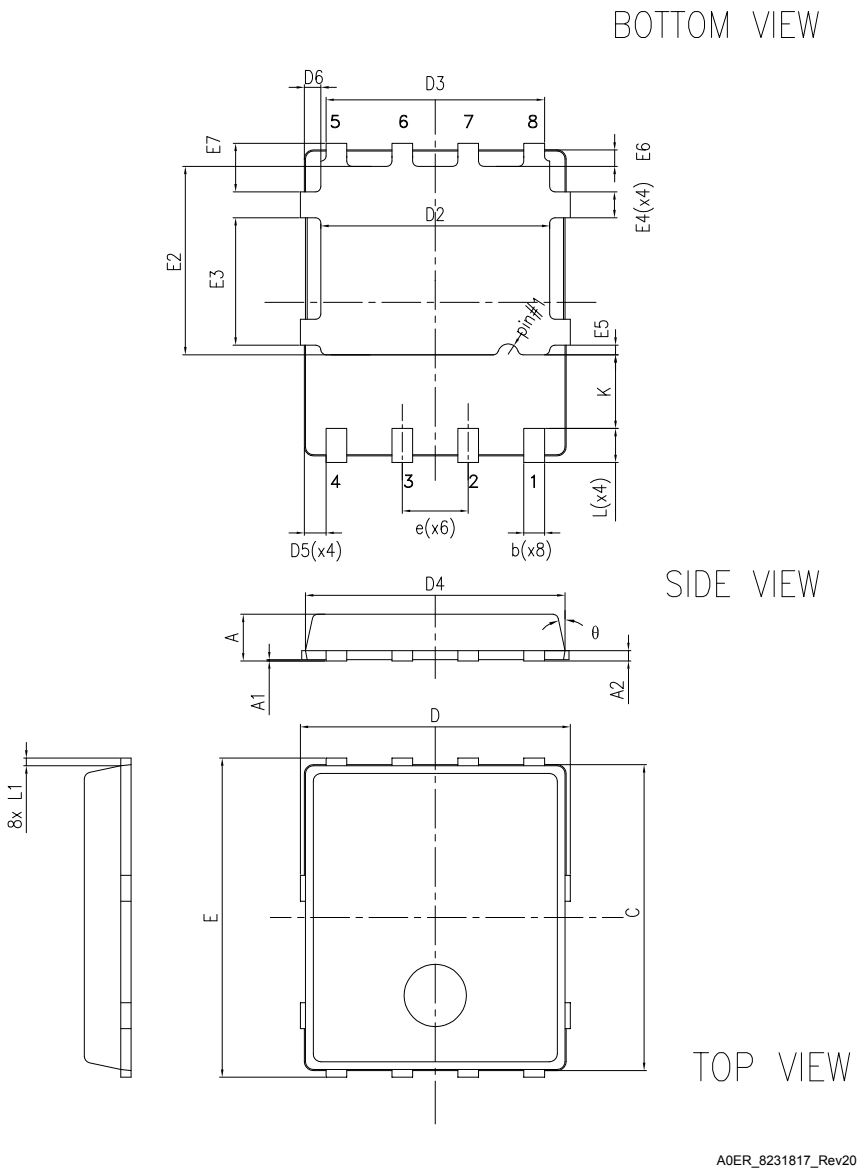



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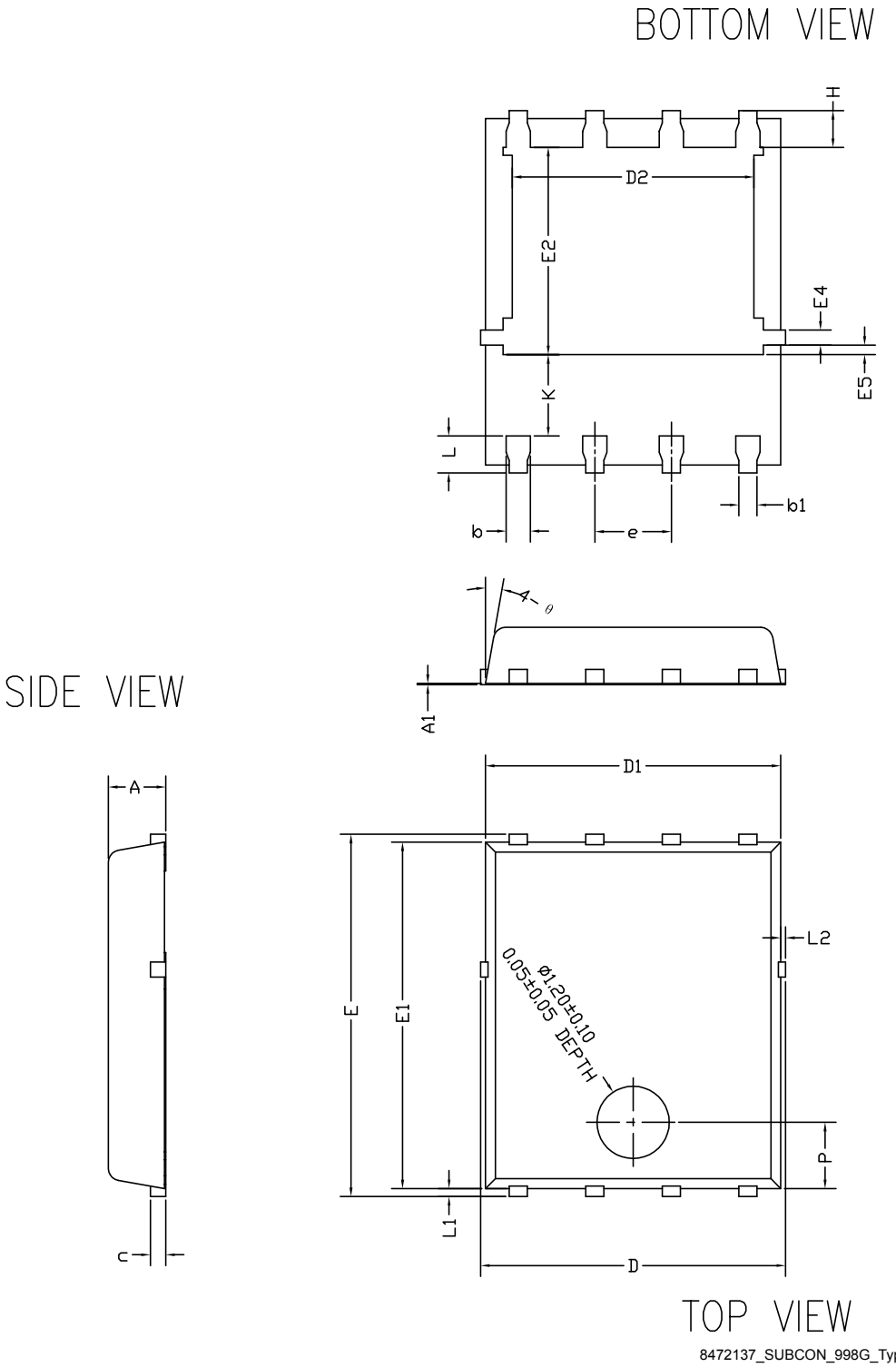
Table 7. **PowerFLAT 5x6 type R mechanical data**

| 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 | 6.20 |
| D | 5.00 | 5.20 | 5.40 |
| D2 | 4.15 | | 4.45 |
| D3 | 4.05 | 4.20 | 4.35 |
| D4 | 4.80 | 5.00 | 5.20 |
| D5 | 0.25 | 0.40 | 0.55 |
| D6 | 0.15 | 0.30 | 0.45 |
| e | | 1.27 | |
| E | 5.95 | 6.15 | 6.35 |
| 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 | 0.75 | 0.90 | 1.05 |
| K | 1.275 | | 1.575 |
| L | 0.60 | | 0.80 |
| L1 | 0.05 | 0.15 | 0.25 |
| θ | 0° | | 12° |

## 4.2 PowerFLAT 5x6 type R SUBCON package information

Figure 19. **PowerFLAT 5x6 type R SUBCON package outline**

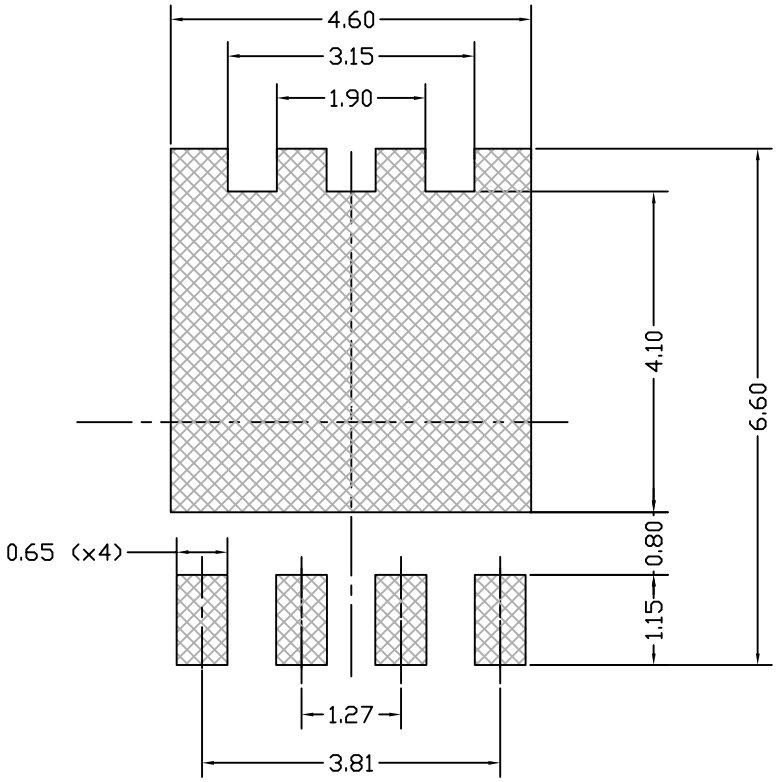



8472137_SUBCON_998G_Type_R_REV4

**Table 8. PowerFLAT 5x6 type R SUBCON package mechanical data**

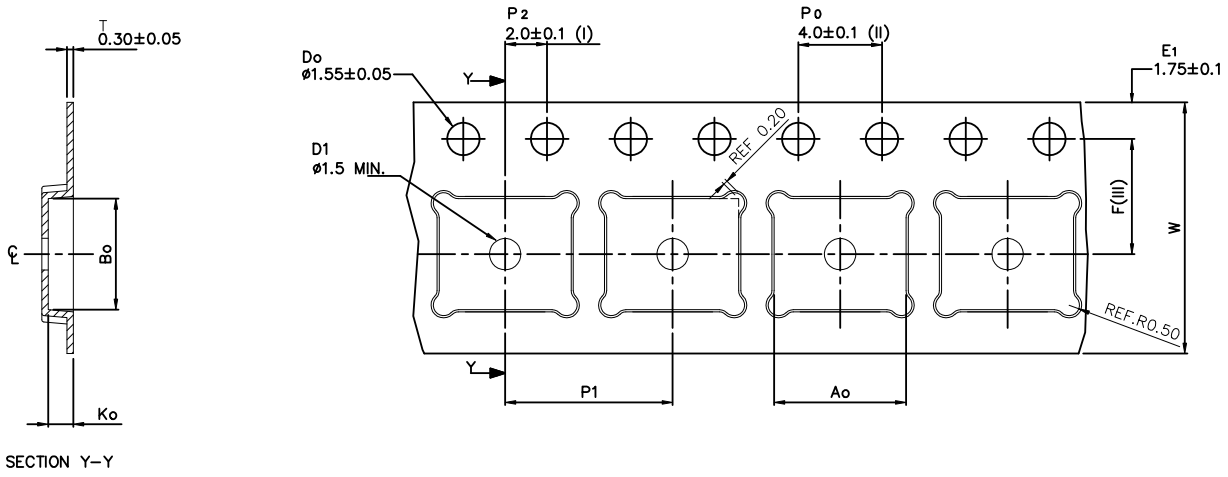
| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 0.90 | 0.95 | 1.00 |
| A1 | | 0.02 | |
| b | 0.35 | 0.40 | 0.45 |
| b1 | | 0.30 | |
| c | 0.21 | 0.25 | 0.34 |
| D | | | 5.10 |
| D1 | 4.80 | 4.90 | 5.00 |
| D2 | 3.91 | 4.01 | 4.11 |
| e | 1.17 | 1.27 | 1.37 |
| E | 5.90 | 6.00 | 6.10 |
| E1 | 5.70 | 5.75 | 5.80 |
| E2 | 3.34 | 3.44 | 3.54 |
| E4 | 0.15 | 0.25 | 0.35 |
| E5 | 0.06 | 0.16 | 0.26 |
| H | 0.51 | 0.61 | 0.71 |
| K | 1.10 | | |
| L | 0.51 | 0.61 | 0.71 |
| L1 | 0.06 | 0.13 | 0.20 |
| L2 | | | 0.10 |
| P | 1.00 | 1.10 | 1.20 |
| θ | 8° | 10° | 12° |

Figure 20. **PowerFLAT 5x6 recommended footprint (dimensions are in mm)**



## 4.3 PowerFLAT 5x6 packing information

**Figure 21. PowerFLAT 5x6 tape (dimensions are in mm)**




| | |
|---|---|
| Ao | 6.30 +/– 0.1 |
| Bo | 5.30 +/– 0.1 |
| Ko | 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 ±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 22. PowerFLAT 5x6 package orientation in carrier tape**

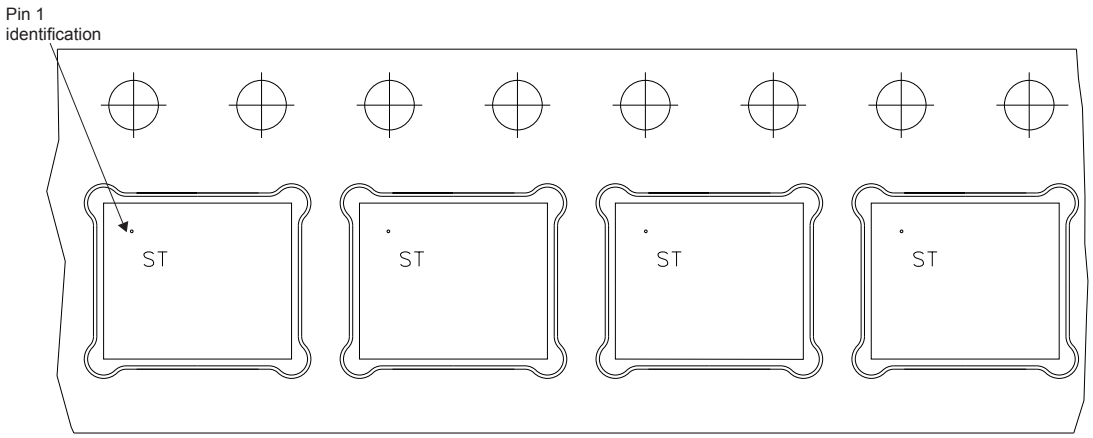
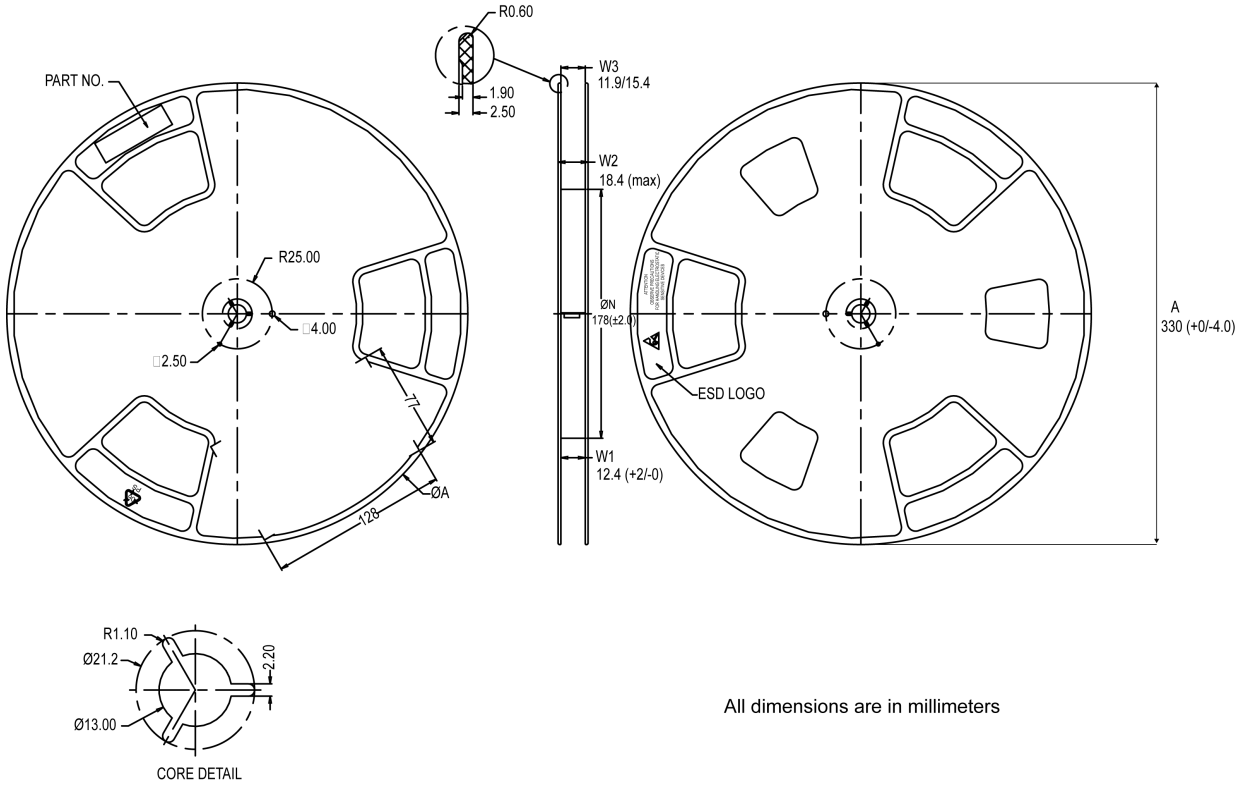


**Figure 23. PowerFLAT 5x6 reel**




All dimensions are in millimeters

8234350_Reel_rev_C

## Revision history

**Table 9. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 29-Mar-2013 | 1 | First release. |
| 23-May-2013 | 2 | – Document status promoted from target data to production data<br>– Modified: $V_{GS(th)}$ values in *Table 4* |
| 28-Oct-2013 | 3 | – Modified: title, $R_{DS(on)}$ in cover page<br>– Modified: $R_{DS(on)}$ typical and max values in *Table 4*, $C_{iss}$ typical value in table 5<br>– Added: $Q_{SS}$ in *Table 5*<br>– Modified: $t_{d(on)}$ and $T_r$ typical values<br>– Modified: $T_{rr}$, $Q_{rr}$ and $I_{RRM}$ typical values in *Table 7*<br>– Added: *Section 2.1: Electrical characteristics (curves)*<br>– Updated: *Section 4: Package mechanical data*<br>– Minor text changes |
| 13-Feb-2020 | 4 | Updated Section 4 Package information.<br>Minor text changes. |

# Contents