

Automotive-grade N-channel 40 V, 0.8 mΩ typ., 200 A STripFET™ F7 Power MOSFETs in H<sup>2</sup>PAK-2 and H<sup>2</sup>PAK-6 packages

Datasheet - production data

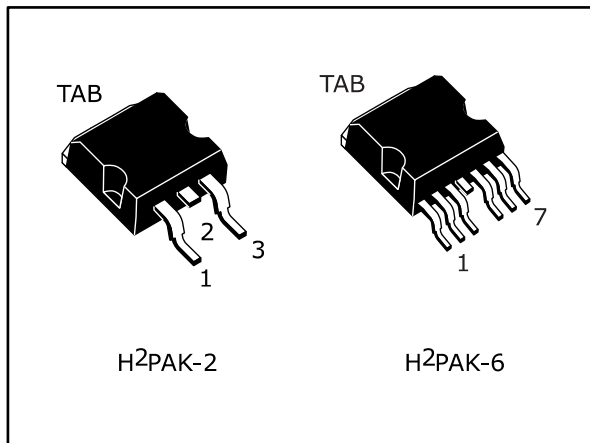
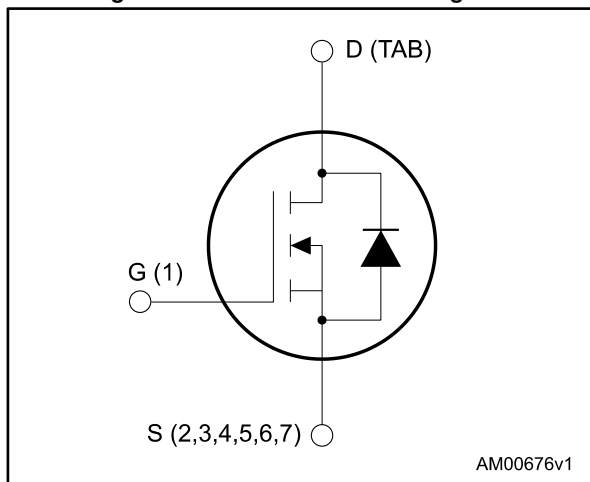


Figure 1: Internal schematic diagram



## Features

| Order code     | V <sub>DS</sub> | R <sub>DS(on)</sub><br>max. | I <sub>D</sub> | P <sub>TOT</sub> |
|----------------|-----------------|-----------------------------|----------------|------------------|
| STH410N4F7-2AG | 40 V            | 1.1 mΩ                      | 200 A          | 365 W            |
| STH410N4F7-6AG |                 |                             |                |                  |

- Designed for automotive applications and AEC-Q101 qualified
- Among the lowest R<sub>DS(on)</sub> on the market
- Excellent figure of merit (FoM)
- Low C<sub>rss</sub>/C<sub>iss</sub> 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.

Table 1: Device summary

| Order code     | Marking | Package              | Packing       |
|----------------|---------|----------------------|---------------|
| STH410N4F7-2AG | 410N4F7 | H <sup>2</sup> PAK-2 | Tape And Reel |
| STH410N4F7-6AG |         | H <sup>2</sup> PAK-6 |               |

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol         | Parameter                                                | Value      | Unit |
|----------------|----------------------------------------------------------|------------|------|
| $V_{DS}$       | Drain-source voltage                                     | 40         | V    |
| $V_{GS}$       | Gate-source voltage                                      | ±20        | V    |
| $I_D^{(1)}$    | Drain current (continuous) at $T_{case} = 25\text{ °C}$  | 200        | A    |
|                | Drain current (continuous) at $T_{case} = 100\text{ °C}$ | 200        |      |
| $I_{DM}^{(2)}$ | Drain current (pulsed)                                   | 800        | A    |
| $P_{TOT}$      | Total dissipation at $T_{case} = 25\text{ °C}$           | 365        | W    |
| $E_{AS}^{(3)}$ | Single pulse avalanche energy                            | 1.9        | J    |
| $T_{stg}$      | Storage temperature range                                | -55 to 175 | °C   |
| $T_j$          | Operating junction temperature range                     |            |      |

**Notes:**

<sup>(1)</sup> Current is limited by package, the current capability of the silicon is 420 A at 25 °C.

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

<sup>(3)</sup>  $T_j \leq 175\text{ °C}$ ,  $I_{av}=80A$

Table 3: Thermal data

| Symbol              | Parameter                        | Value | Unit |
|---------------------|----------------------------------|-------|------|
| $R_{thj-case}$      | Thermal resistance junction-case | 0.41  | °C/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 board, 2oz Cu.

## 2 Electrical characteristics

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

**Table 4: Static**

| Symbol                      | Parameter                         | Test conditions                                                                                                   | Min. | Typ. | Max. | Unit          |
|-----------------------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{(\text{BR})\text{DSS}}$ | Drain-source breakdown voltage    | $V_{\text{GS}} = 0\text{ V}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$                                            | 40   |      |      | V             |
| $I_{\text{DSS}}$            | Zero gate voltage drain current   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 40\text{ V}$                                                      |      |      | 10   | $\mu\text{A}$ |
|                             |                                   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 40\text{ V}$ ,<br>$T_{\text{case}} = 125\text{ }^{\circ}\text{C}$ |      |      | 100  |               |
| $I_{\text{GSS}}$            | Gate-body leakage current         | $V_{\text{DS}} = 0\text{ V}$ , $V_{\text{GS}} = 20\text{ V}$                                                      |      |      | 200  | nA            |
| $V_{\text{GS(th)}}$         | Gate threshold voltage            | $V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$                                         | 2.5  |      | 4.5  | V             |
| $R_{\text{DS(on)}}$         | Static drain-source on-resistance | $V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 90\text{ A}$                                                      |      | 0.8  | 1.1  | m $\Omega$    |

**Table 5: 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>$V_{\text{GS}} = 0\text{ V}$                                                                                       | -    | 11500 | -    | pF   |
| $C_{\text{oss}}$ | Output capacitance           |                                                                                                                                                                            | -    | 3500  | -    |      |
| $C_{\text{rss}}$ | Reverse transfer capacitance |                                                                                                                                                                            | -    | 390   | -    |      |
| $Q_{\text{g}}$   | Total gate charge            | $V_{\text{DD}} = 20\text{ V}$ , $I_{\text{D}} = 180\text{ A}$ ,<br>$V_{\text{GS}} = 10\text{ V}$ (see <a href="#">Figure 14: "Test circuit for gate charge behavior"</a> ) | -    | 141   | -    | nC   |
| $Q_{\text{gs}}$  | Gate-source charge           |                                                                                                                                                                            | -    | 65    | -    |      |
| $Q_{\text{gd}}$  | Gate-drain charge            |                                                                                                                                                                            | -    | 27    | -    |      |

**Table 6: Switching times**

| Symbol              | Parameter           | Test conditions                                                                                                                                                                                                                                                                 | Min. | Typ. | Max. | Unit |
|---------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{\text{d(on)}}$  | Turn-on delay time  | $V_{\text{DD}} = 20\text{ V}$ , $I_{\text{D}} = 90\text{ A}$<br>$R_{\text{G}} = 4.7\text{ }\Omega$ , $V_{\text{GS}} = 10\text{ V}$ (see <a href="#">Figure 13: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 18: "Switching time waveform"</a> ) | -    | 35   | -    | ns   |
| $t_{\text{r}}$      | Rise time           |                                                                                                                                                                                                                                                                                 | -    | 198  | -    |      |
| $t_{\text{d(off)}}$ | Turn-off delay time |                                                                                                                                                                                                                                                                                 | -    | 108  | -    |      |
| $t_{\text{f}}$      | Fall time           |                                                                                                                                                                                                                                                                                 | -    | 44.2 | -    |      |

Table 7: Source-drain diode

| Symbol         | Parameter                | Test conditions                                                                                                                                                                                                        | Min. | Typ. | Max. | Unit |
|----------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}^{(1)}$ | Source-drain current     |                                                                                                                                                                                                                        | -    |      | 200  | A    |
| $V_{SD}^{(2)}$ | Forward on voltage       | $V_{GS} = 0\text{ V}$ , $I_{SD} = 90\text{ A}$                                                                                                                                                                         | -    |      | 1.3  | V    |
| $t_{rr}$       | Reverse recovery time    | $I_{SD} = 180\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 32\text{ V}$ , $T_j = 25\text{ °C}$ (see <a href="#">Figure 15: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 74.4 |      | ns   |
| $Q_{rr}$       | Reverse recovery charge  |                                                                                                                                                                                                                        | -    | 115  |      | nC   |
| $I_{RRM}$      | Reverse recovery current |                                                                                                                                                                                                                        | -    | 3.1  |      | A    |

**Notes:**

<sup>(1)</sup> Limited by package, 420 A current allowed by silicon.

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

## 2.2 Electrical characteristics (curves)

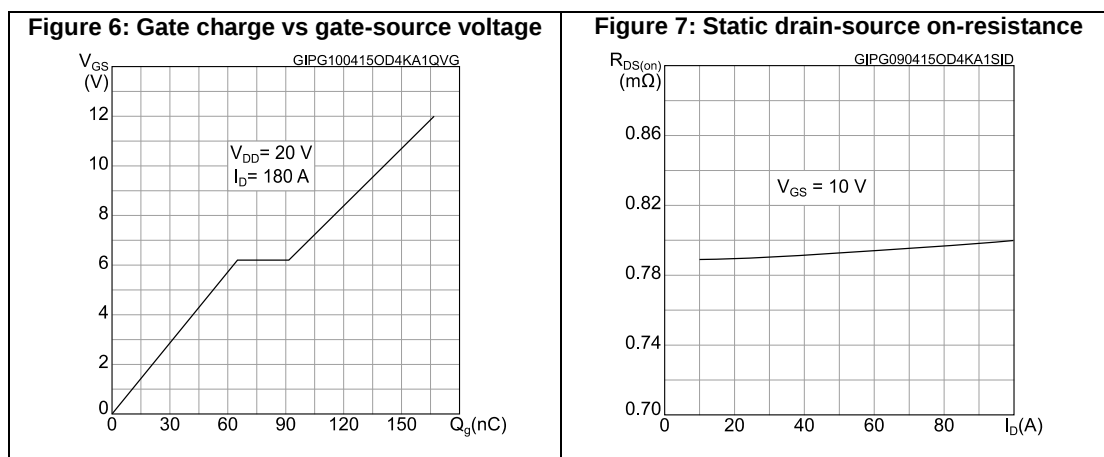
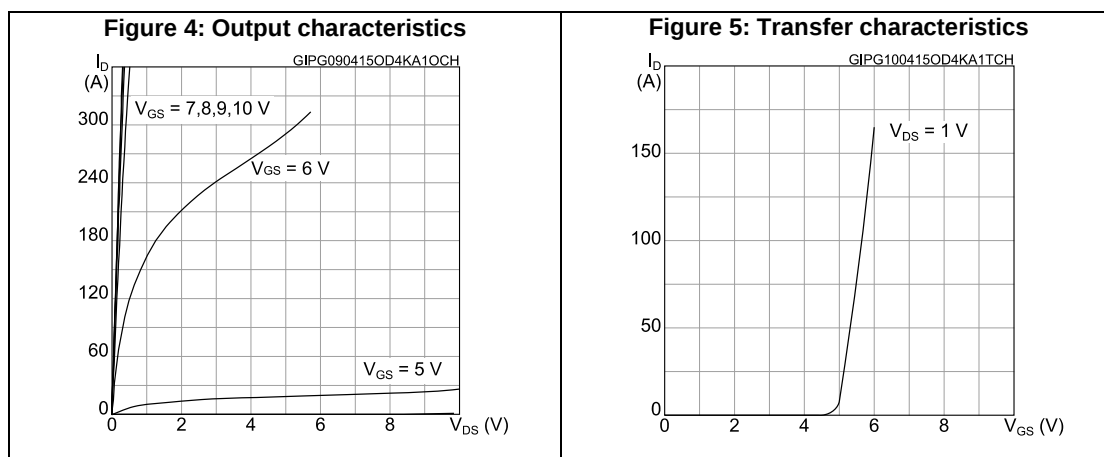
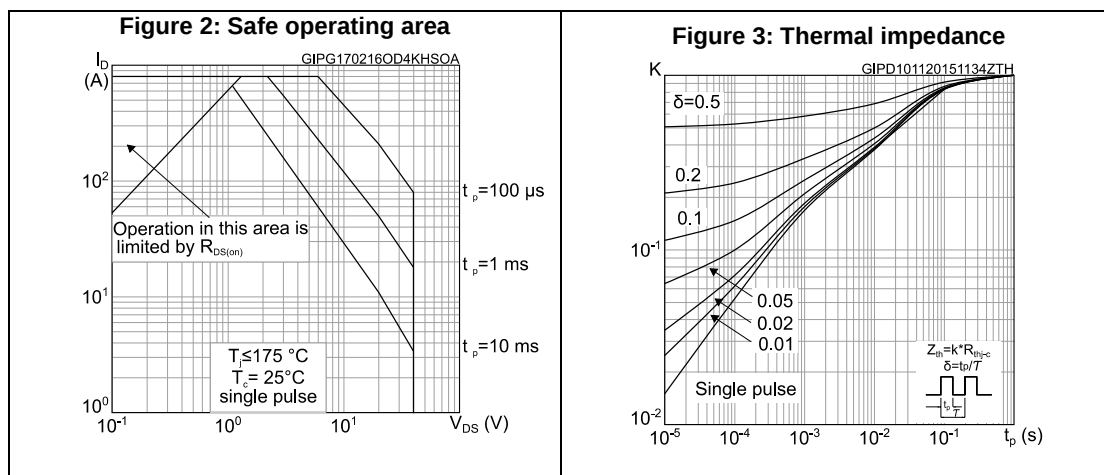


Figure 8: Capacitance variations

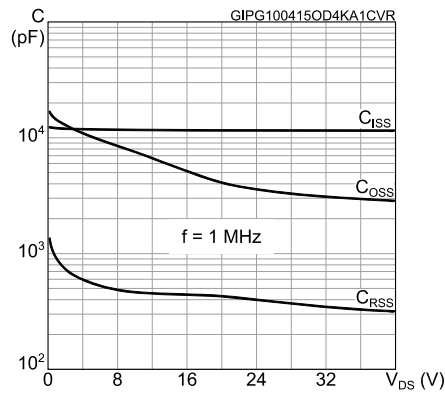


Figure 9: Normalized gate threshold voltage vs temperature

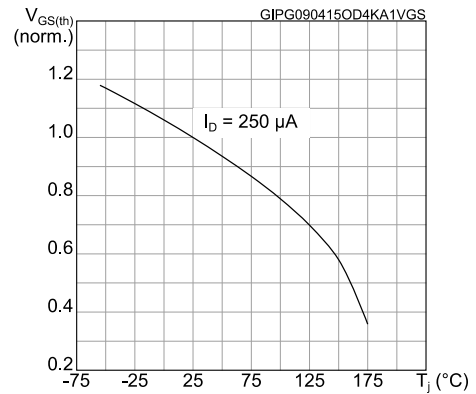


Figure 10: Normalized on-resistance vs temperature

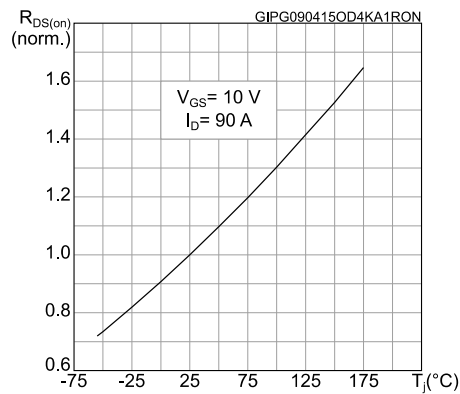


Figure 11: Normalized  $V_{(BR)DSS}$  vs temperature

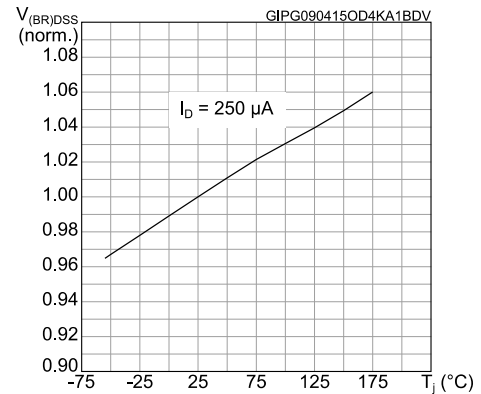
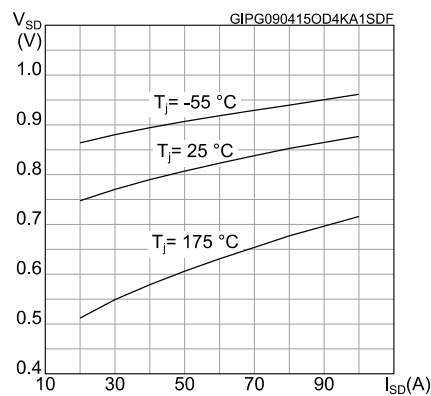
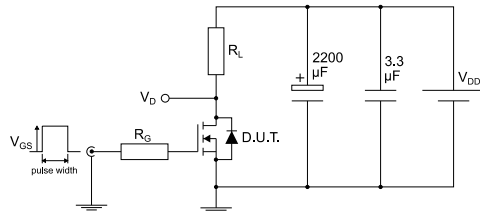


Figure 12: Source-drain diode forward characteristics



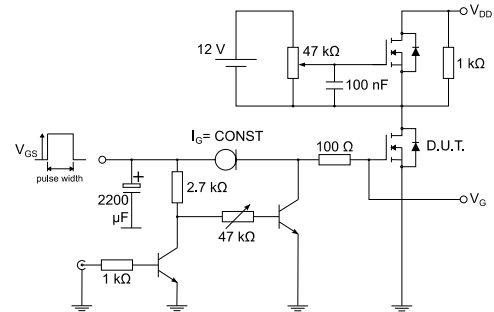
### 3 Test circuits

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



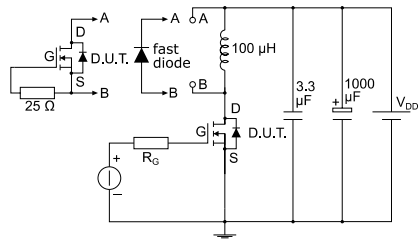
AM01468v1

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



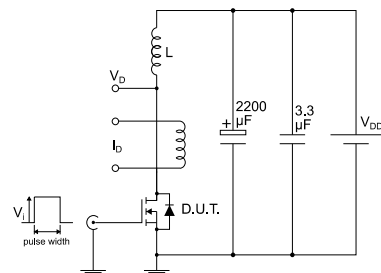
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**Figure 15: Test circuit for inductive load switching and diode recovery times**



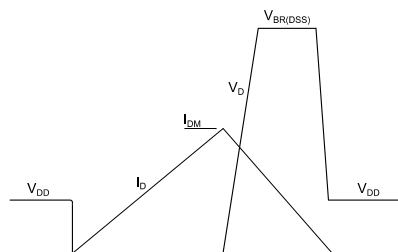
AM01470v1

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



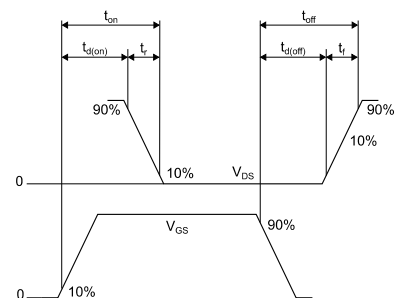
AM01471v1

**Figure 17: Unclamped inductive waveform**



AM01472v1

**Figure 18: Switching time waveform**



AM01473v1

## 4 Package information

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 H<sup>2</sup>PAK-2 package information

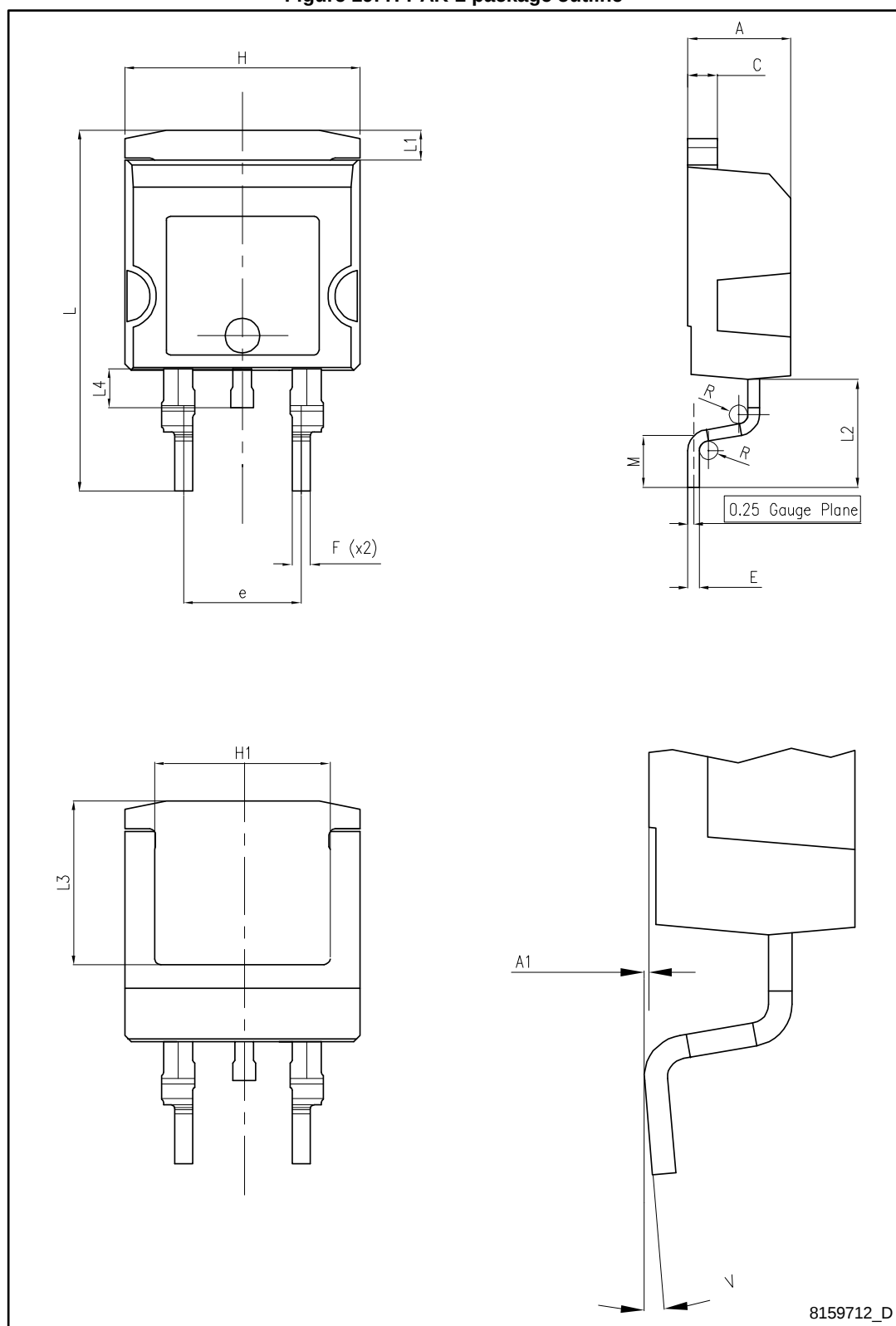
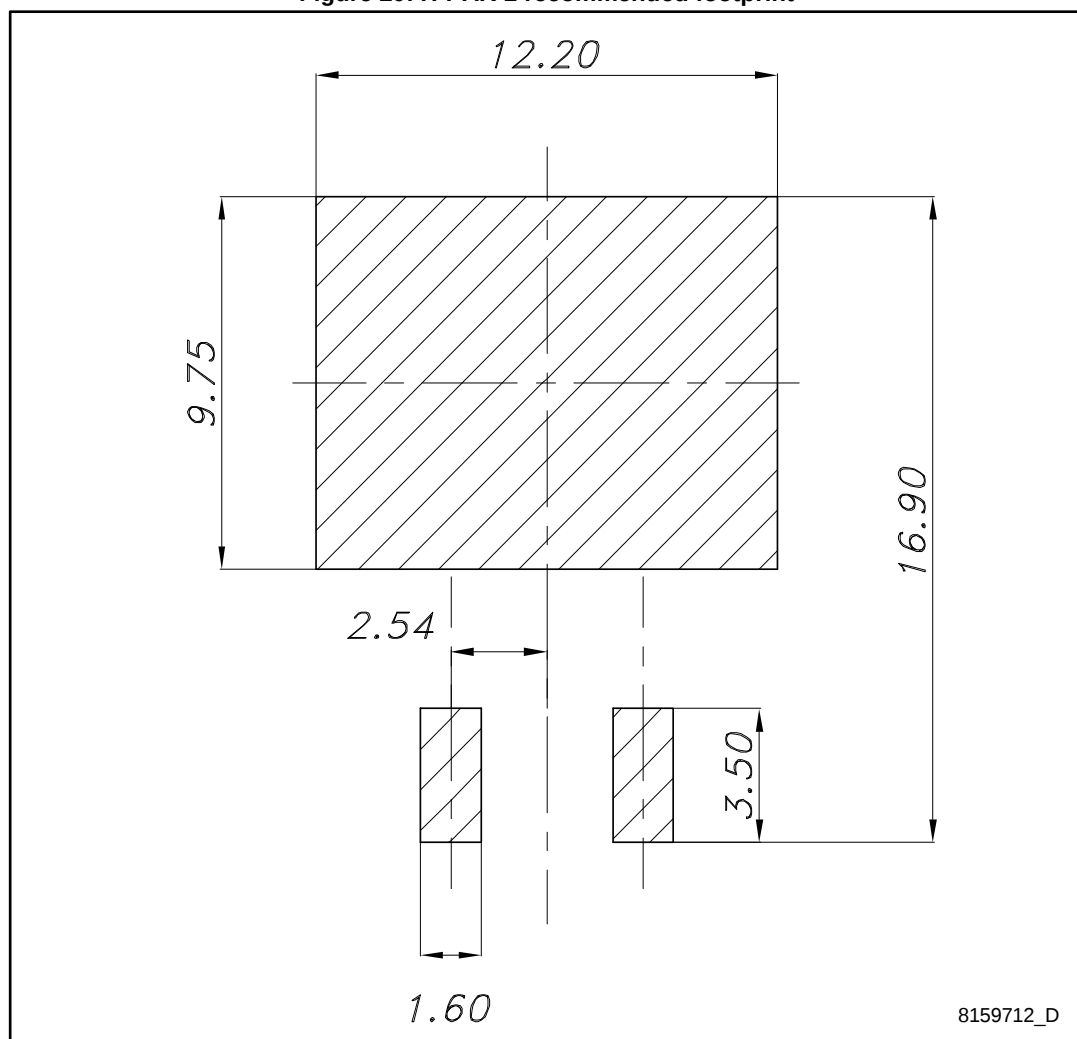
Figure 19: H<sup>2</sup>PAK-2 package outline

Table 8: H<sup>2</sup>PAK-2 package mechanical data

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.30  | -    | 4.80  |
| A1   | 0.03  |      | 0.20  |
| C    | 1.17  |      | 1.37  |
| e    | 4.98  |      | 5.18  |
| E    | 0.50  |      | 0.90  |
| F    | 0.78  |      | 0.85  |
| H    | 10.00 |      | 10.40 |
| H1   | 7.40  |      | 7.80  |
| L    | 15.30 |      | 15.80 |
| L1   | 1.27  |      | 1.40  |
| L2   | 4.93  |      | 5.23  |
| L3   | 6.85  |      | 7.25  |
| L4   | 1.5   |      | 1.7   |
| M    | 2.6   |      | 2.9   |
| R    | 0.20  |      | 0.60  |
| V    | 0°    |      | 8°    |

Figure 20: H<sup>2</sup>PAK-2 recommended footprint

## 4.2 H<sup>2</sup>PAK-6 package information

Figure 21: H<sup>2</sup>PAK-6 package outline

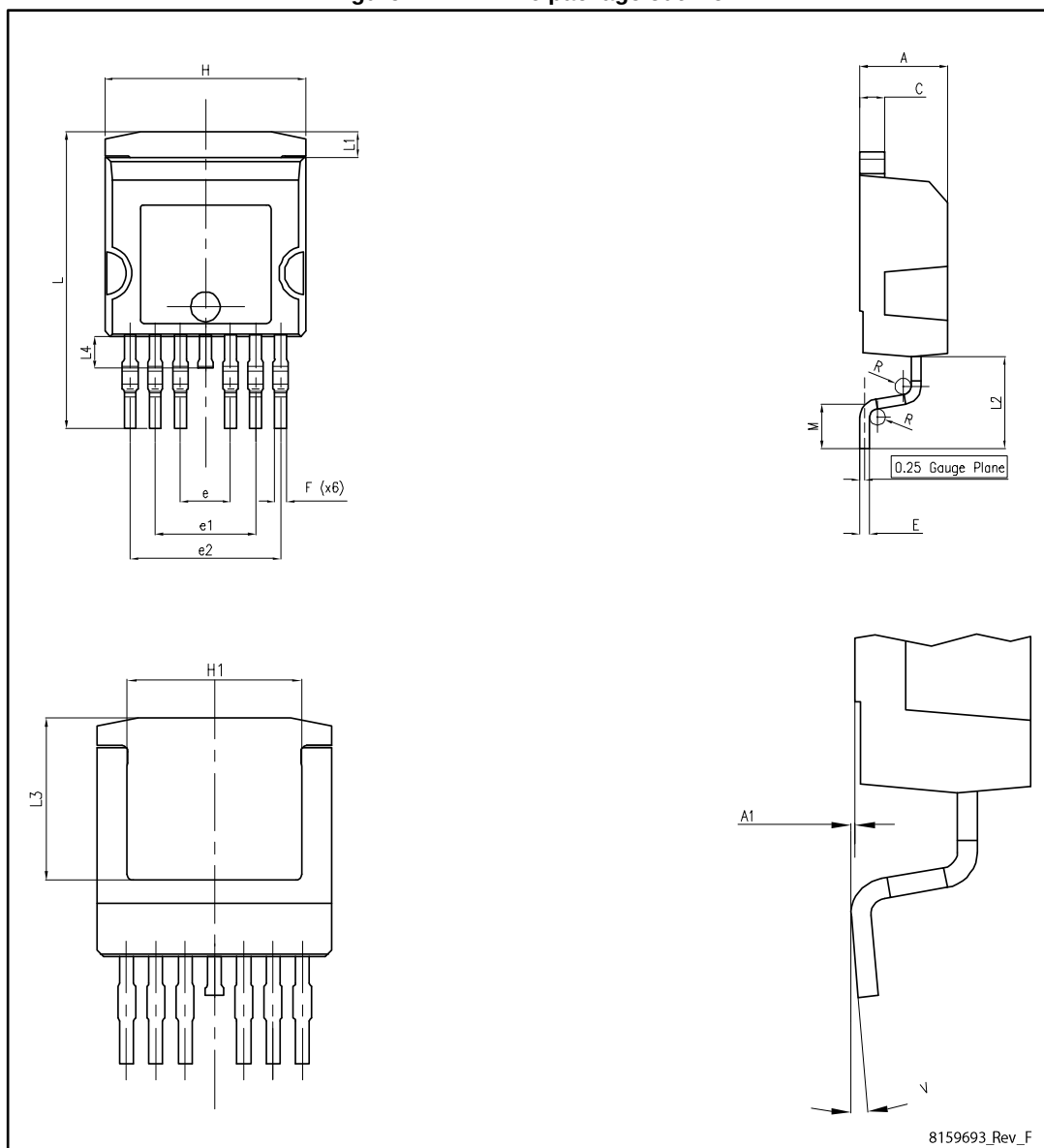
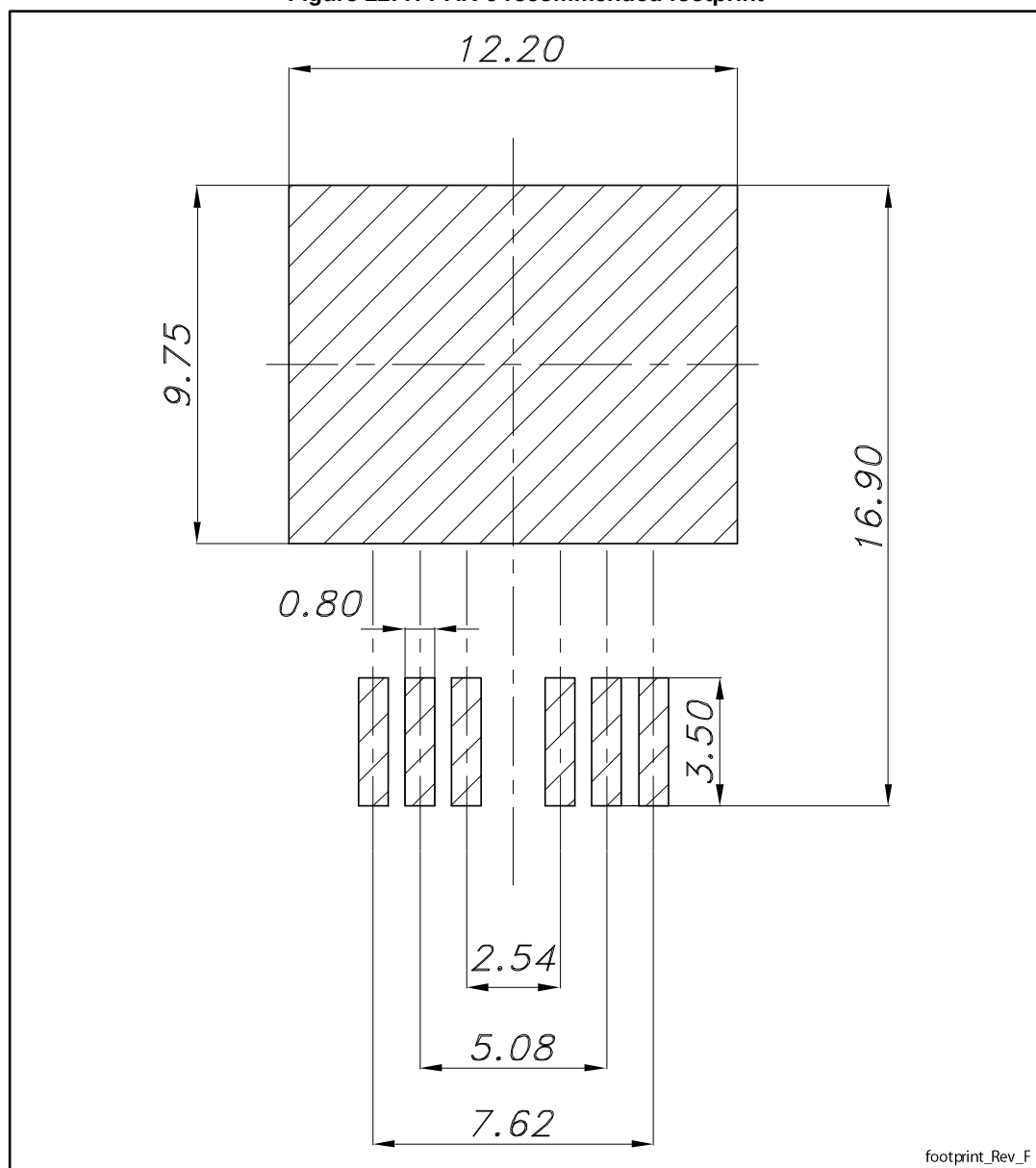


Table 9: H<sup>2</sup>PAK-6 package mechanical data

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.30  | -    | 4.80  |
| A1   | 0.03  |      | 0.20  |
| C    | 1.17  |      | 1.37  |
| e    | 2.34  |      | 2.74  |
| e1   | 4.88  |      | 5.28  |
| e2   | 7.42  |      | 7.82  |
| E    | 0.45  |      | 0.60  |
| F    | 0.50  |      | 0.70  |
| H    | 10.00 |      | 10.40 |
| H1   | 7.40  |      | 7.80  |
| L    | 14.75 |      | 15.25 |
| L1   | 1.27  |      | 1.40  |
| L2   | 4.35  |      | 4.95  |
| L3   | 6.85  |      | 7.25  |
| L4   | 1.5   |      | 1.75  |
| M    | 1.90  |      | 2.50  |
| R    | 0.20  |      | 0.60  |
| V    | 0°    |      | 8°    |

Figure 22: H<sup>2</sup>PAK-6 recommended footprint



Dimensions are in mm.

### 4.3 H<sup>2</sup>PAK packing information

Figure 23: Tape outline

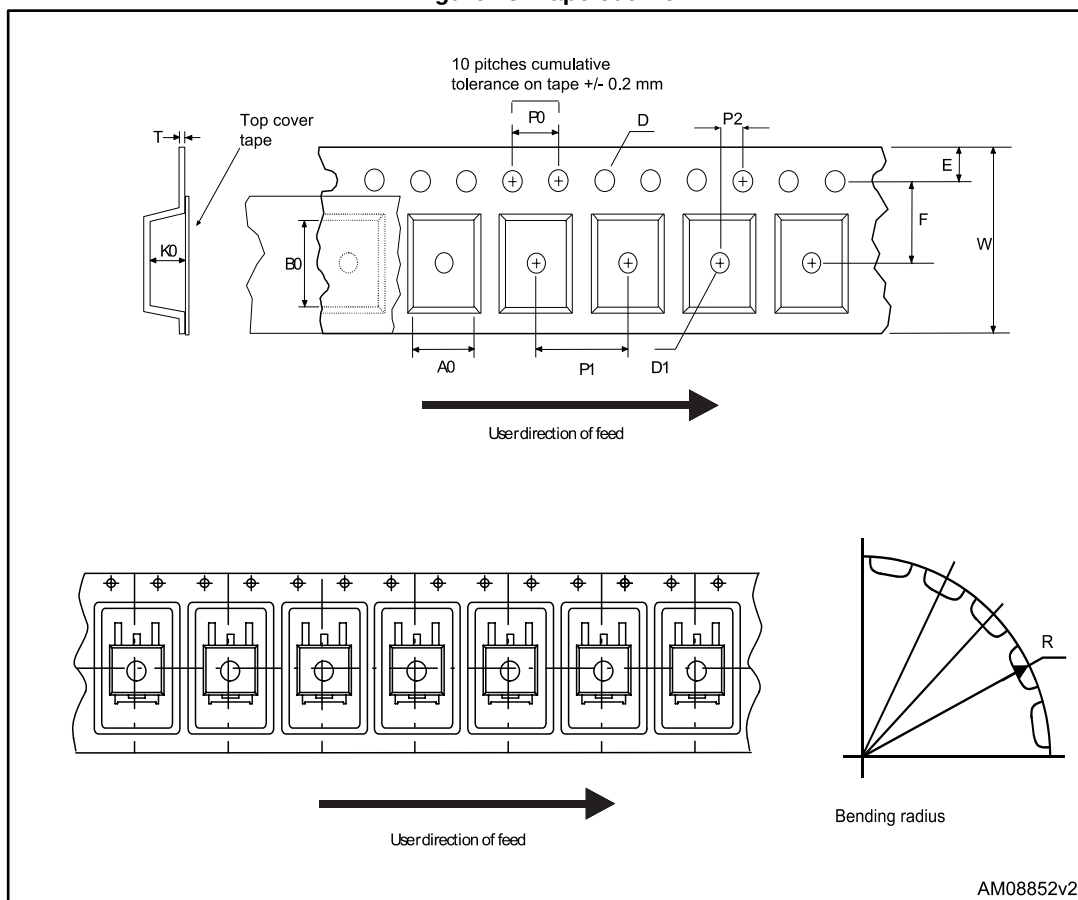


Figure 24: Reel outline

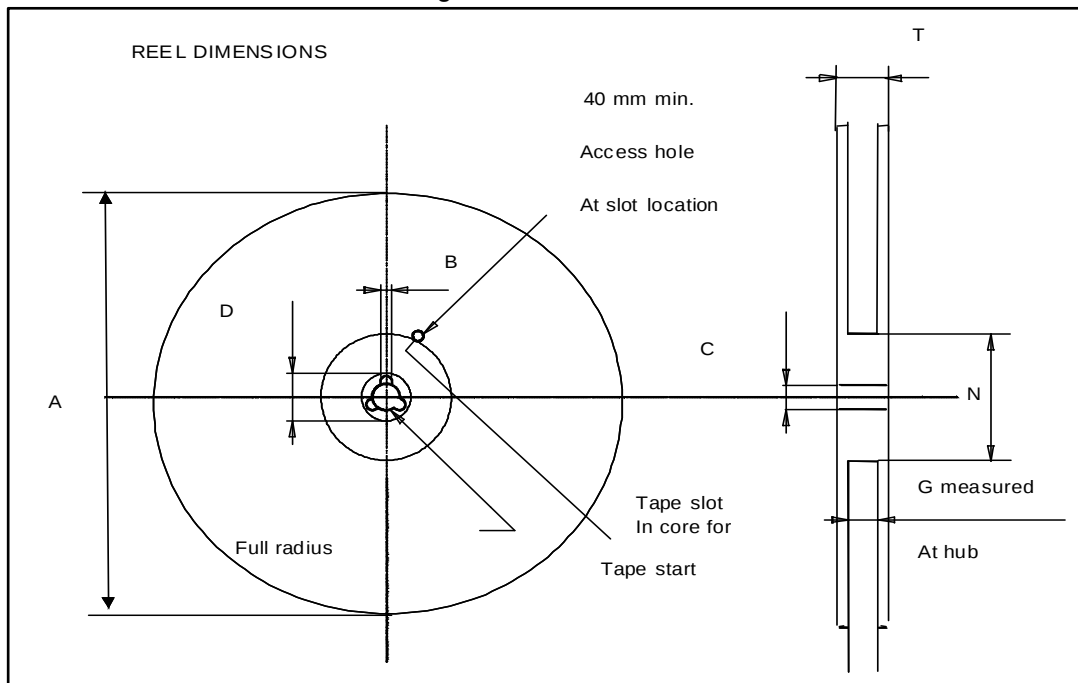


Table 10: Tape and reel mechanical data

| 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 quantity |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk quantity |      | 1000 |
| R    | 50   |      |               |      |      |
| T    | 0.25 | 0.35 |               |      |      |
| W    | 23.7 | 24.3 |               |      |      |

## 5 Revision history

**Table 11: Document revision history**

| Date        | Revision | Changes                                                                                                                                                   |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10-Apr-2015 | 1        | First release.                                                                                                                                            |
| 13-May-2015 | 2        | Updated Static.                                                                                                                                           |
| 04-Dec-2015 | 3        | Updated note 1 in Table 2: "Absolute maximum ratings",<br>Figure 2: "Safe operating area" and Figure 3: "Thermal impedance".                              |
| 17-Feb-2016 | 4        | Modified: <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 4: "Static"</i><br>Modified: <i>Figure 2: "Safe operating area"</i><br>Minor text changes |

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