

# STFW3N150, STH3N150-2, STP3N150, STW3N150

N-channel 1500 V, 2.5 A, 6  $\Omega$  typ., PowerMESH™ Power MOSFETs  
in TO-3PF, H<sup>2</sup>PAK-2, TO-220 and TO247 packages

Datasheet - production data

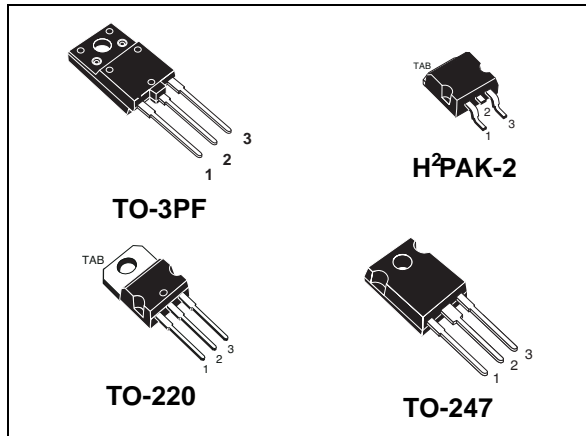
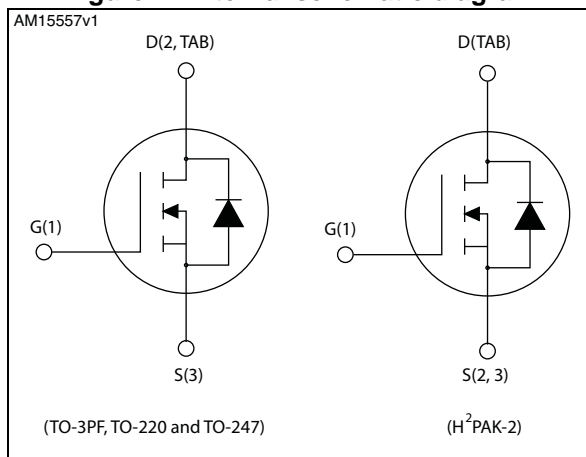


Figure 1. Internal schematic diagram



## Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|--------------------------|----------------|------------------|
| STFW3N150   | 1500 V          | 9 $\Omega$               | 2.5 A          | 63 W             |
| STH3N150-2  |                 |                          |                | 140 W            |
| STP3N150    |                 |                          |                |                  |
| STW3N150    |                 |                          |                |                  |

- 100% avalanche tested
- Intrinsic capacitances and Q<sub>g</sub> minimized
- High speed switching
- Fully isolated TO-3PF plastic package, creepage distance path is 5.4 mm (typ.)

## Applications

- Switching applications

## Description

These Power MOSFETs are designed using the company's consolidated strip layout-based MESH OVERLAY™ process. The result is a product that matches or improves on the performance of comparable standard parts from other manufacturers.

Table 1. Device summary

| Order codes | Marking | Packages             | Packaging     |
|-------------|---------|----------------------|---------------|
| STFW3N150   | 3N150   | TO-3PF               | Tube          |
| STH3N150-2  |         | H <sup>2</sup> PAK-2 | Tape and reel |
| STP3N150    |         | TO-220               | Tube          |
| STW3N150    |         | TO-247               |               |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter                                                                                                    | Value              |                                            | Unit |
|--------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------|--------------------------------------------|------|
|                                |                                                                                                              | TO-3PF             | H <sup>2</sup> PAK-2,<br>TO-220,<br>TO-247 |      |
| V <sub>DS</sub>                | Drain-source voltage                                                                                         | 1500               |                                            | V    |
| V <sub>GS</sub>                | Gate-source voltage                                                                                          | ± 30               |                                            | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                         | 2.5 <sup>(1)</sup> | 2.5                                        | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                        | 1.6 <sup>(1)</sup> | 1.6                                        | A    |
| I <sub>DM</sub> <sup>(1)</sup> | Drain current (pulsed)                                                                                       | 10 <sup>(1)</sup>  | 10                                         | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                  | 63                 | 140                                        | W    |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C) | 3500               |                                            | V    |
|                                | Derating factor                                                                                              | 0.5                | 1.12                                       | W/°C |
| T <sub>stg</sub>               | Storage temperature                                                                                          | -50 to 150         |                                            | °C   |
| T <sub>j</sub>                 | Max. operating junction temperature                                                                          | 150                |                                            | °C   |

1. Pulse width limited by safe operating area

**Table 3. Thermal data**

| Symbol                | Parameter                               | TO-3PF | H <sup>2</sup> PAK-2 | TO-220 | TO-247 | Unit |
|-----------------------|-----------------------------------------|--------|----------------------|--------|--------|------|
| R <sub>thj-case</sub> | Thermal resistance junction-case max    | 2      | 0.89                 |        |        | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max | 50     |                      | 62.5   | 50     | °C/W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb max     |        | 35 <sup>(1)</sup>    |        |        | °C/W |

1. When mounted on 1 inch<sup>2</sup> FR-4 board, 2 oz Cu

**Table 4. Avalanche characteristics**

| Symbol          | Parameter                                                                                                                  | Max value | Unit |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|-----------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)                                | 2.5       | A    |
| E <sub>AS</sub> | Single pulse avalanche energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 450       | mJ   |

## 2 Electrical characteristics

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

**Table 5. On /off states**

| Symbol                      | Parameter                                               | Test conditions                                                           | Min. | Typ. | Max.      | Unit          |
|-----------------------------|---------------------------------------------------------|---------------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(\text{BR})\text{DSS}}$ | Drain-source breakdown voltage                          | $I_{\text{D}} = 1\text{ mA}$ , $V_{\text{GS}} = 0$                        | 1500 |      |           | V             |
| $I_{\text{DSS}}$            | Zero gate voltage drain current ( $V_{\text{GS}} = 0$ ) | $V_{\text{DS}} = 1500\text{ V}$                                           |      |      | 10        | $\mu\text{A}$ |
|                             |                                                         | $V_{\text{DS}} = 1500\text{ V}$ , $T_{\text{C}} = 125\text{ °C}$          |      |      | 500       | $\mu\text{A}$ |
| $I_{\text{GSS}}$            | Gate-body leakage current ( $V_{\text{DS}} = 0$ )       | $V_{\text{GS}} = \pm 30\text{ V}$                                         |      |      | $\pm 100$ | nA            |
| $V_{\text{GS(th)}}$         | Gate threshold voltage                                  | $V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$ | 3    | 4    | 5         | V             |
| $R_{\text{DS(on)}}$         | Static drain-source on-resistance                       | $V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 1.3\text{ A}$             |      | 6    | 9         | $\Omega$      |

**Table 6. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                      | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|--------------------------------------------------------------------------------------|------|------|------|----------|
| $g_{\text{fs}}^{(1)}$      | Forward transconductance      | $V_{\text{DS}} = 30\text{ V}$ , $I_{\text{D}} = 1.3\text{ A}$                        | -    | 2.6  | -    | S        |
| $C_{\text{iss}}$           | Input capacitance             | $V_{\text{DS}} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0$             | -    | 939  | -    | pF       |
|                            |                               |                                                                                      | -    |      | -    | pF       |
|                            |                               |                                                                                      | -    |      | -    | pF       |
| $C_{\text{oss}}$           | Output capacitance            | $V_{\text{DS}} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0$             | -    | 102  | -    | pF       |
| $C_{\text{riss}}$          | Reverse transfer capacitance  |                                                                                      | -    | 13.2 | -    | pF       |
| $C_{\text{oss eq.}}^{(2)}$ | Equivalent output capacitance | $V_{\text{DS}} = 0$ to $1200\text{ V}$ , $V_{\text{GS}} = 0$                         | -    | 100  | -    | pF       |
| $R_{\text{g}}$             | Gate input resistance         | $f = 1\text{ MHz}$ , gate DC Bias = 0, test signal level = 20 mV, $I_{\text{D}} = 0$ | -    | 4    | -    | $\Omega$ |
| $Q_{\text{g}}$             | Total gate charge             | $V_{\text{DD}} = 1200\text{ V}$ , $I_{\text{D}} = 2.5\text{ A}$ ,                    | -    | 29.3 | -    | nC       |
| $Q_{\text{gs}}$            | Gate-source charge            | $V_{\text{GS}} = 10\text{ V}$                                                        | -    | 4.6  | -    | nC       |
| $Q_{\text{gd}}$            | Gate-drain charge             | (Figure 19)                                                                          | -    | 17   | -    | nC       |

1. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

2.  $C_{\text{oss eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{\text{oss}}$  when  $V_{\text{DS}}$  increases from 0 to 80%  $V_{\text{DSS}}$

Table 7. Switching times

| Symbol       | Parameter           | Test conditions                                                                                                             | Min. | Typ. | Max. | Unit |
|--------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 750 \text{ V}$ , $I_D = 1.25 \text{ A}$ ,<br>$R_G = 4.7 \text{ } \Omega$ , $V_{GS} = 10 \text{ V}$<br>(Figure 18) | -    | 24   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                             | -    | 47   | -    | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                             | -    | 45   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                             | -    | 61   | -    | ns   |

Table 8. Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                               | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                               | -    |      | 2.5  | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                               | -    |      | 10   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 2.5 \text{ A}$ , $V_{GS} = 0$                                                                                                       | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$<br>$V_{DD} = 60 \text{ V}$<br>(Figure 20)                                      | -    | 410  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                               | -    | 2.4  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                               | -    | 11.7 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$<br>$V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$<br>(Figure 20) | -    | 540  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                               | -    | 3.3  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                               | -    | 12.3 |      | A             |

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-3PF

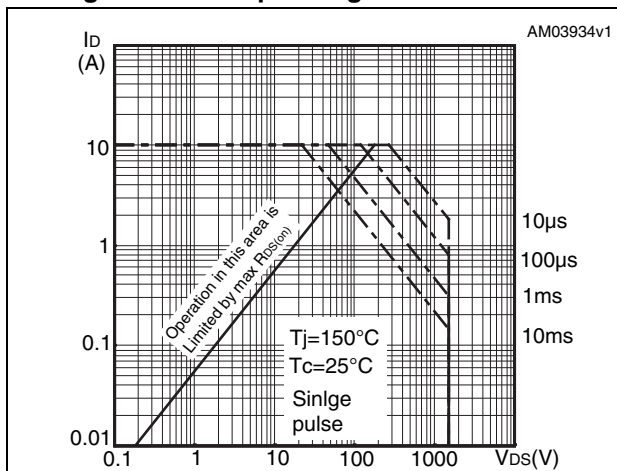


Figure 3. Thermal impedance for TO-3PF

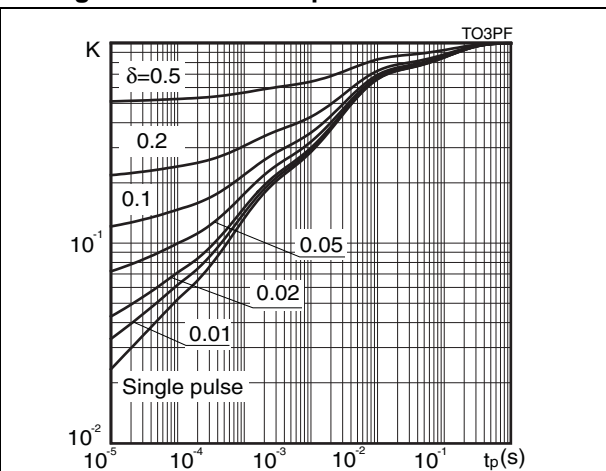


Figure 4. Safe operating area for H<sup>2</sup>PAK-2 and TO-220

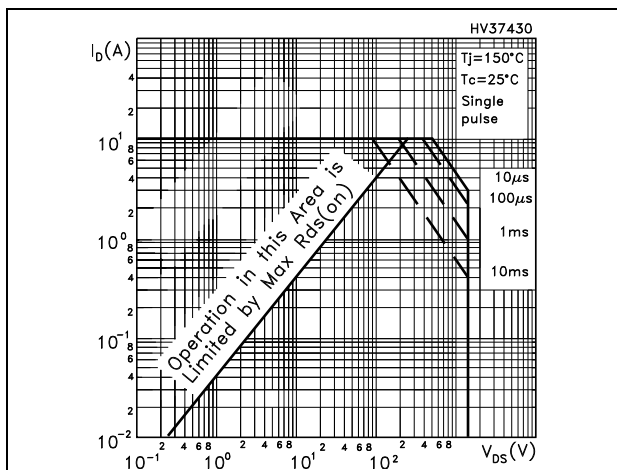


Figure 5. Thermal impedance for H<sup>2</sup>PAK-2 and TO-220

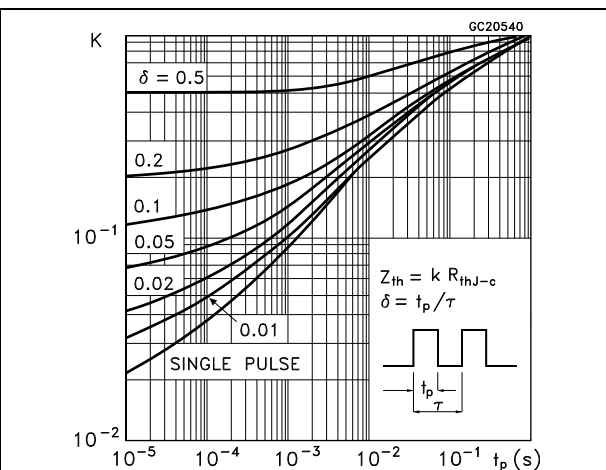


Figure 6. Safe operating area for TO-247

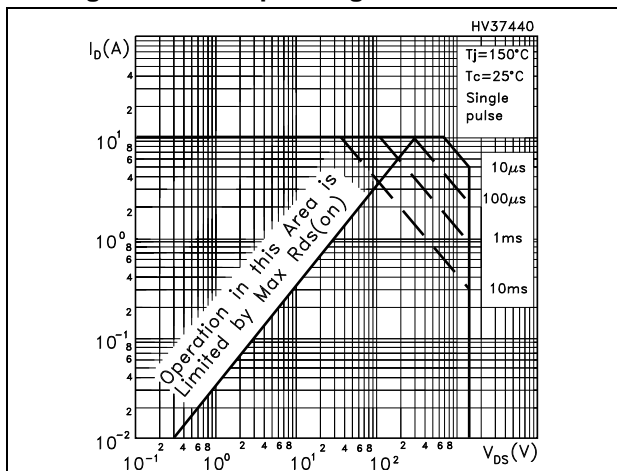


Figure 7. Thermal impedance for TO-247

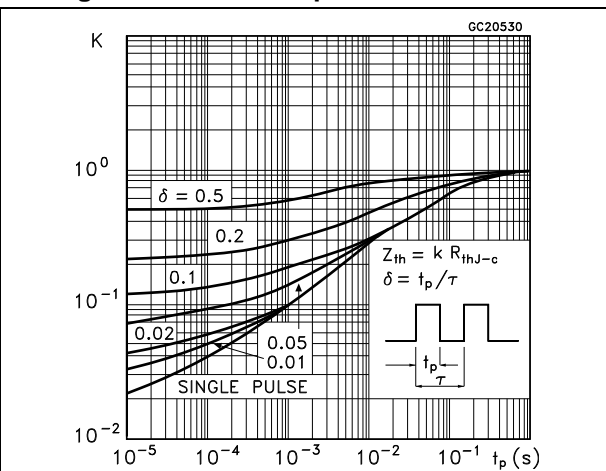


Figure 8. Output characteristics

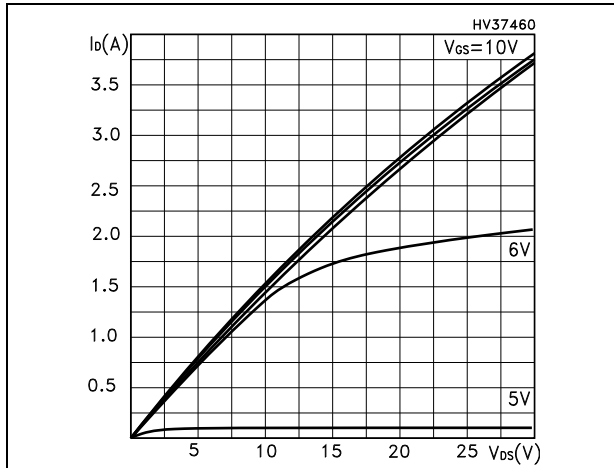


Figure 9. Transfer characteristics

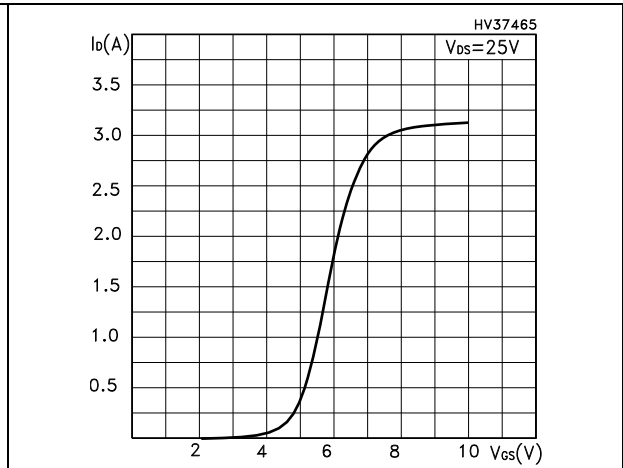


Figure 10. Normalized  $BV_{DSS}$  vs. temperature

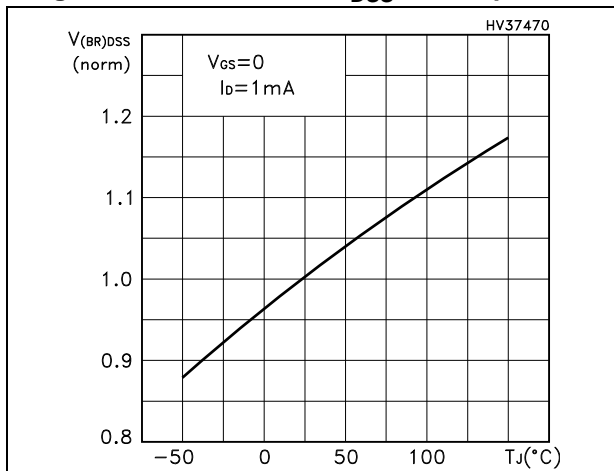


Figure 11. Static drain-source on-resistance

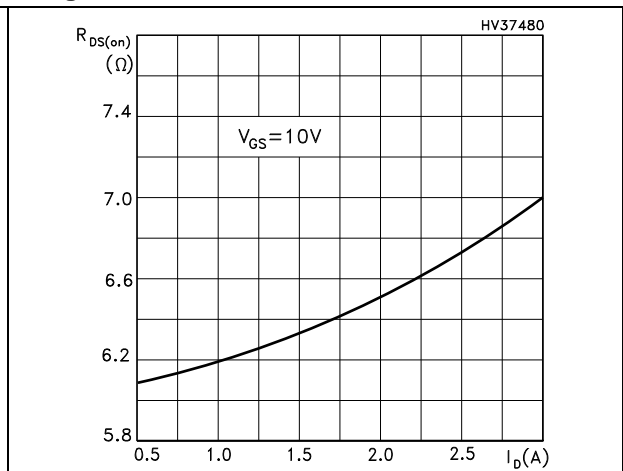


Figure 12. Gate charge vs. gate-source voltage

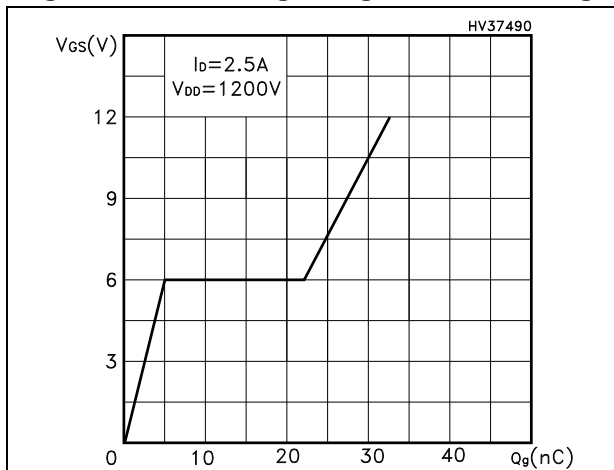


Figure 13. Capacitance variations

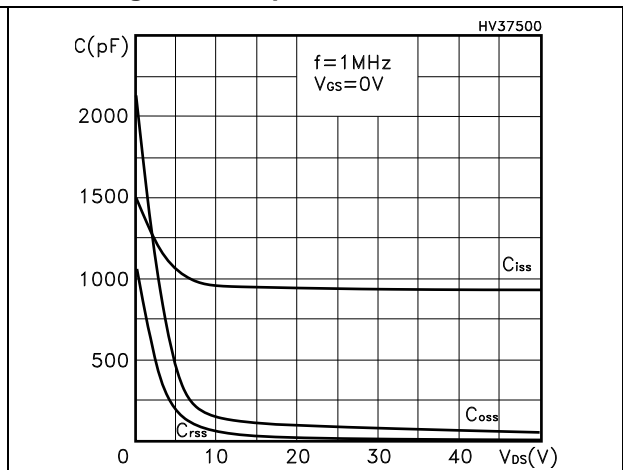


Figure 14. Normalized gate threshold voltage vs. temperature

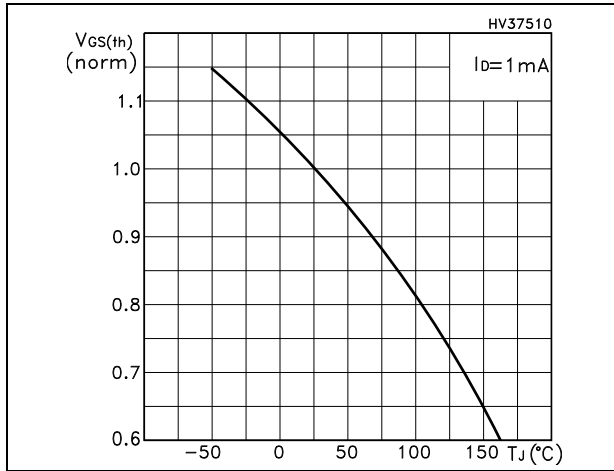


Figure 15. Normalized on resistance vs. temperature

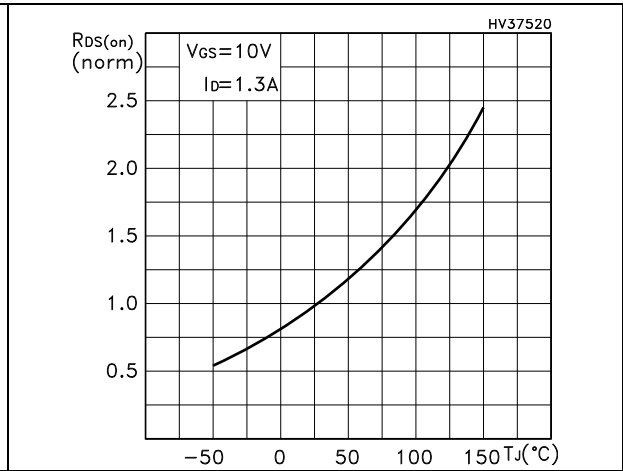


Figure 16. Source-drain diode forward characteristics

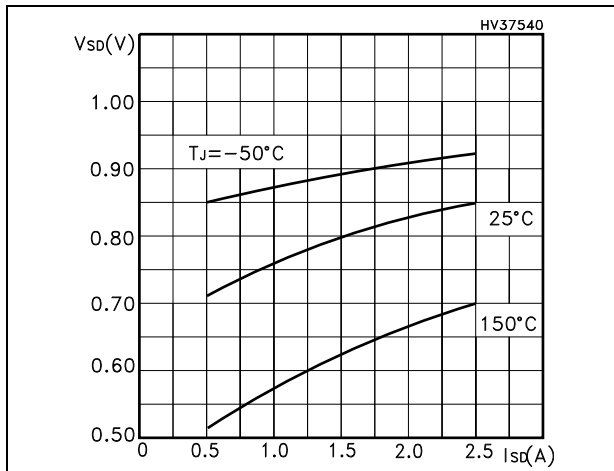
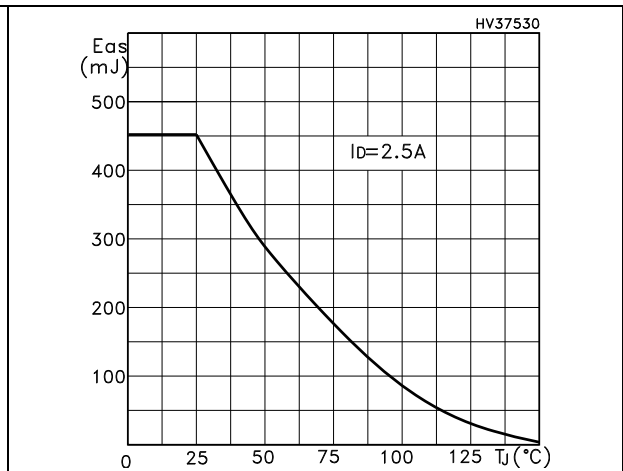


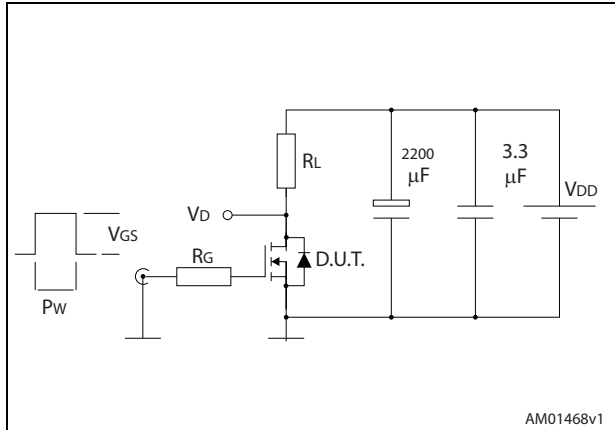
Figure 17. Maximum avalanche energy vs  $T_J$





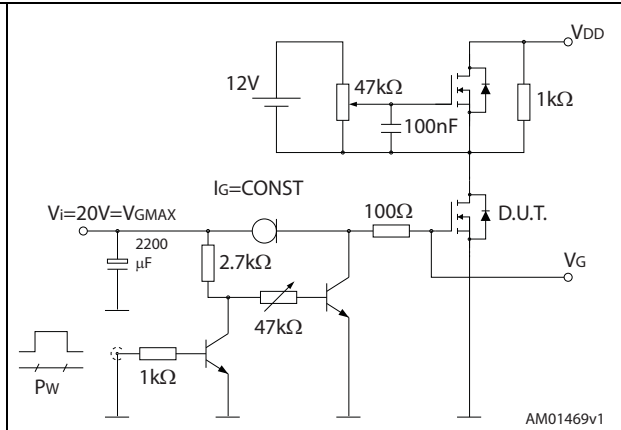
### 3 Test circuits

Figure 18. Switching times test circuit for resistive load



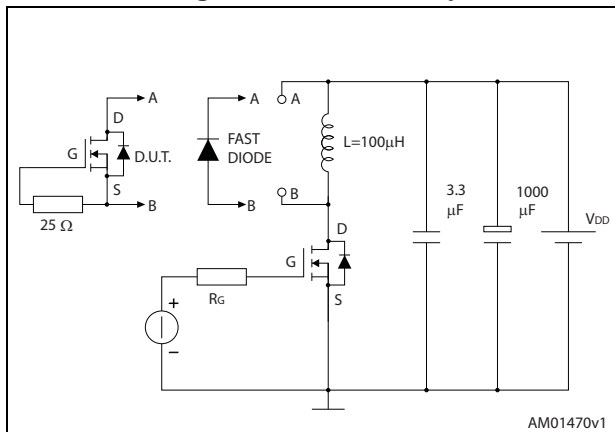
AM01468v1

Figure 19. Gate charge test circuit



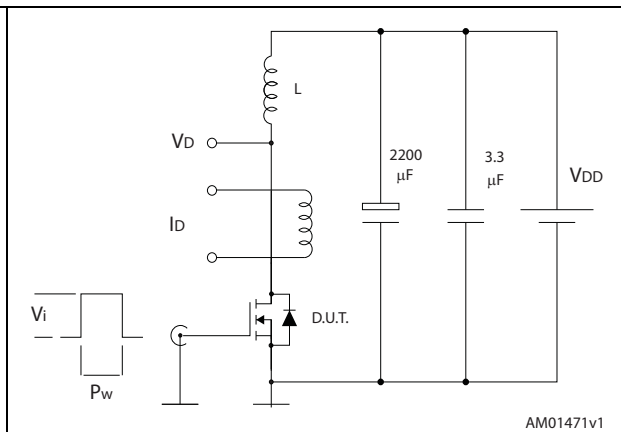
AM01469v1

Figure 20. Test circuit for inductive load switching and diode recovery times



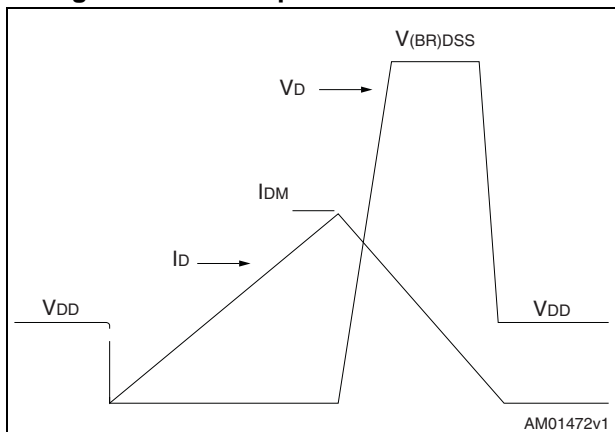
AM01470v1

Figure 21. Unclamped inductive load test circuit



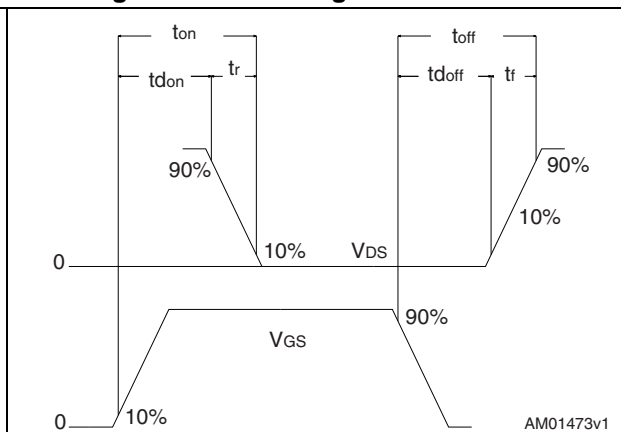
AM01471v1

Figure 22. Unclamped inductive waveform



AM01472v1

Figure 23. Switching time waveform

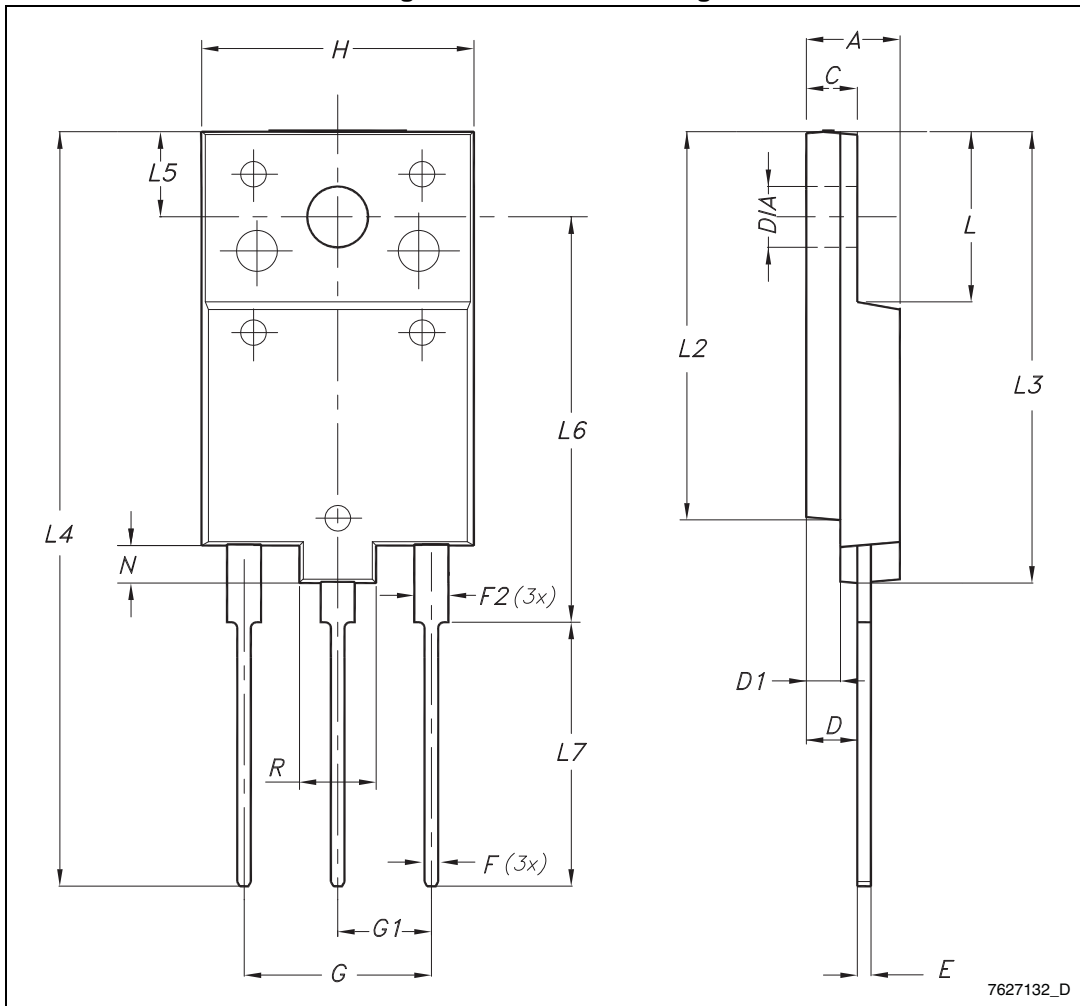


AM01473v1

## 4 Package mechanical data

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.

Figure 24. TO-3PF drawing



7627132\_D

Table 9. TO-3PF mechanical data

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 5.30  |      | 5.70  |
| C    | 2.80  |      | 3.20  |
| D    | 3.10  |      | 3.50  |
| D1   | 1.80  |      | 2.20  |
| E    | 0.80  |      | 1.10  |
| F    | 0.65  |      | 0.95  |
| F2   | 1.80  |      | 2.20  |
| G    | 10.30 |      | 11.50 |
| G1   |       | 5.45 |       |
| H    | 15.30 |      | 15.70 |
| L    | 9.80  | 10   | 10.20 |
| L2   | 22.80 |      | 23.20 |
| L3   | 26.30 |      | 26.70 |
| L4   | 43.20 |      | 44.40 |
| L5   | 4.30  |      | 4.70  |
| L6   | 24.30 |      | 24.70 |
| L7   | 14.60 |      | 15    |
| N    | 1.80  |      | 2.20  |
| R    | 3.80  |      | 4.20  |
| Dia  | 3.40  |      | 3.80  |

Figure 25. H<sup>2</sup>PAK-2 drawing

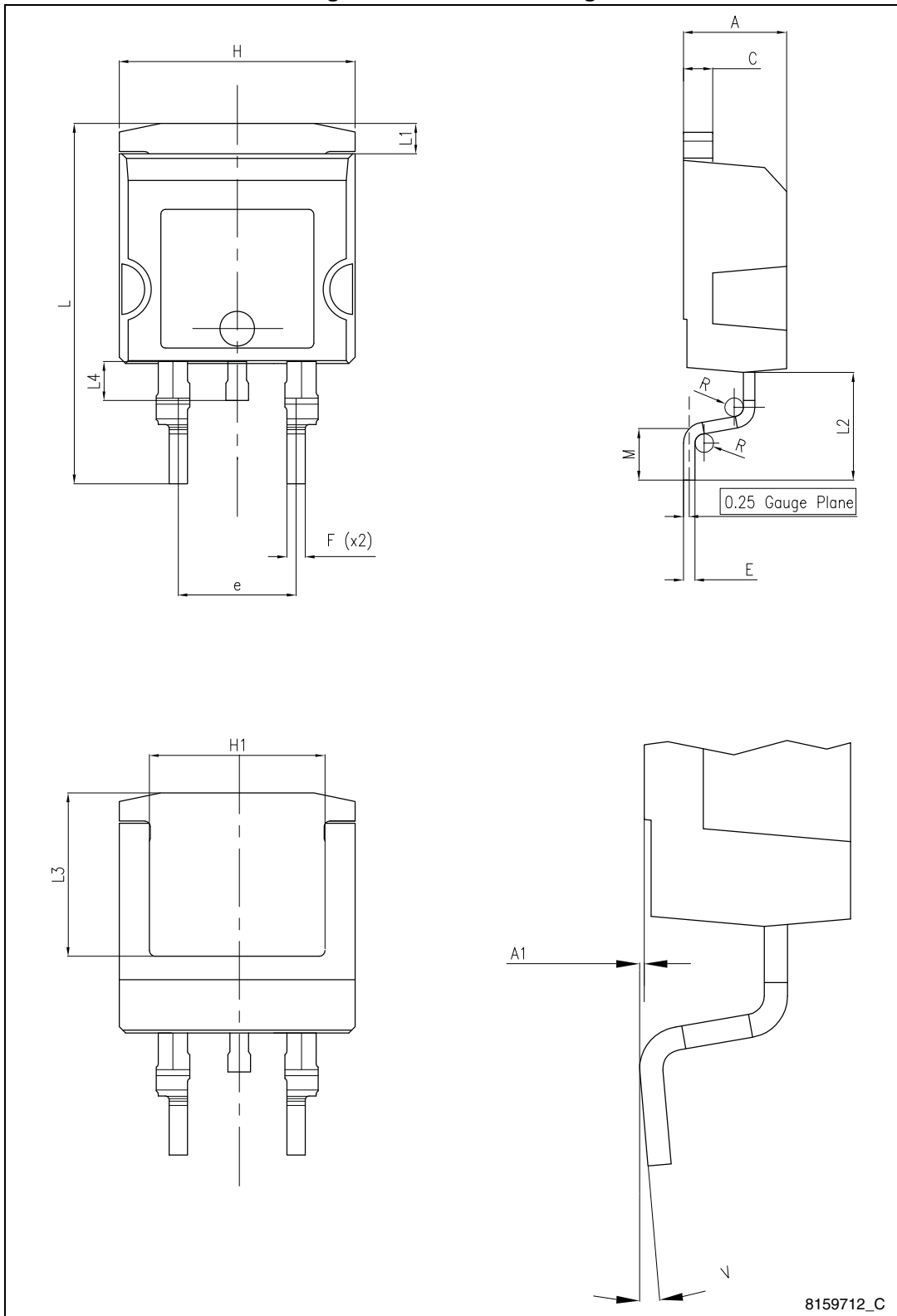


Table 10. H<sup>2</sup>PAK-2 mechanical data

| 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 26. H<sup>2</sup>PAK-2 recommended footprint (dimensions are in mm)

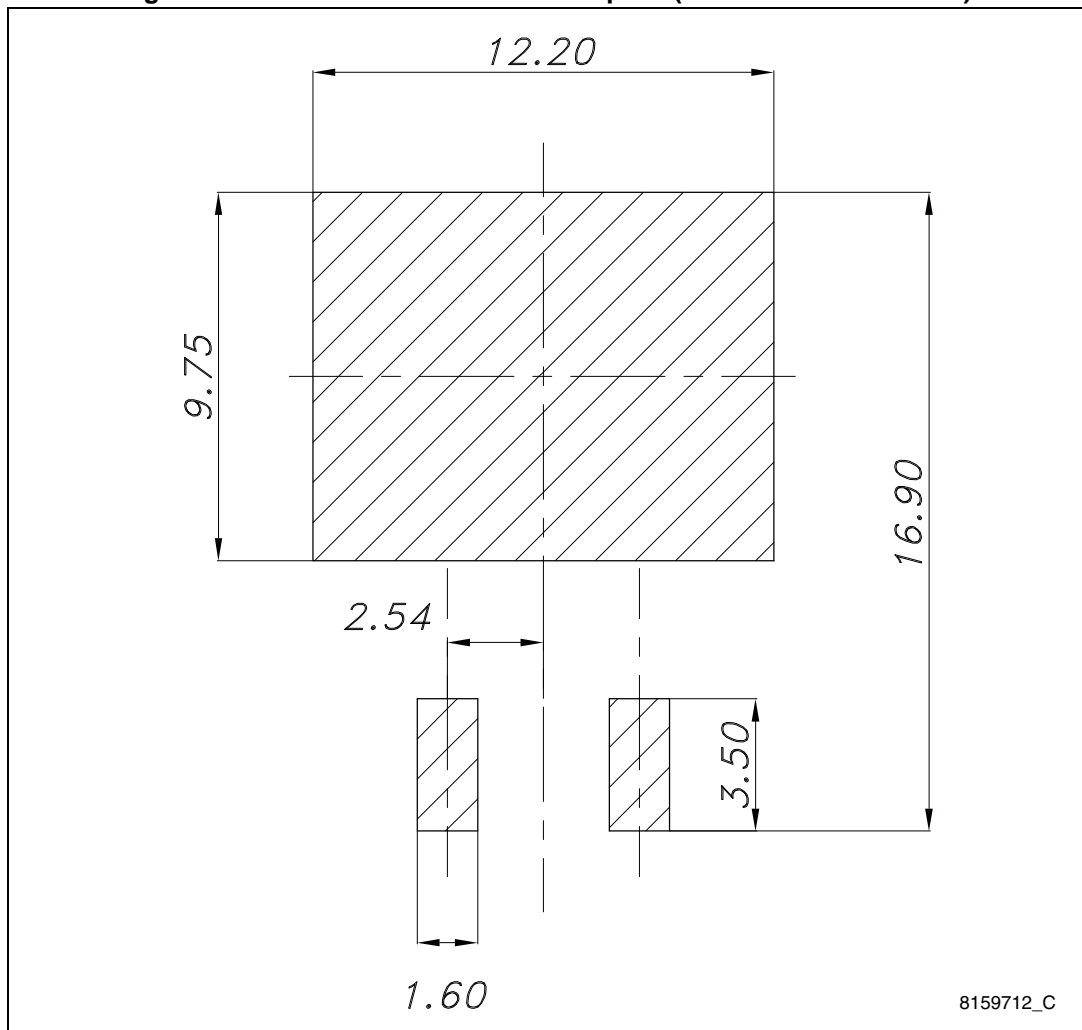
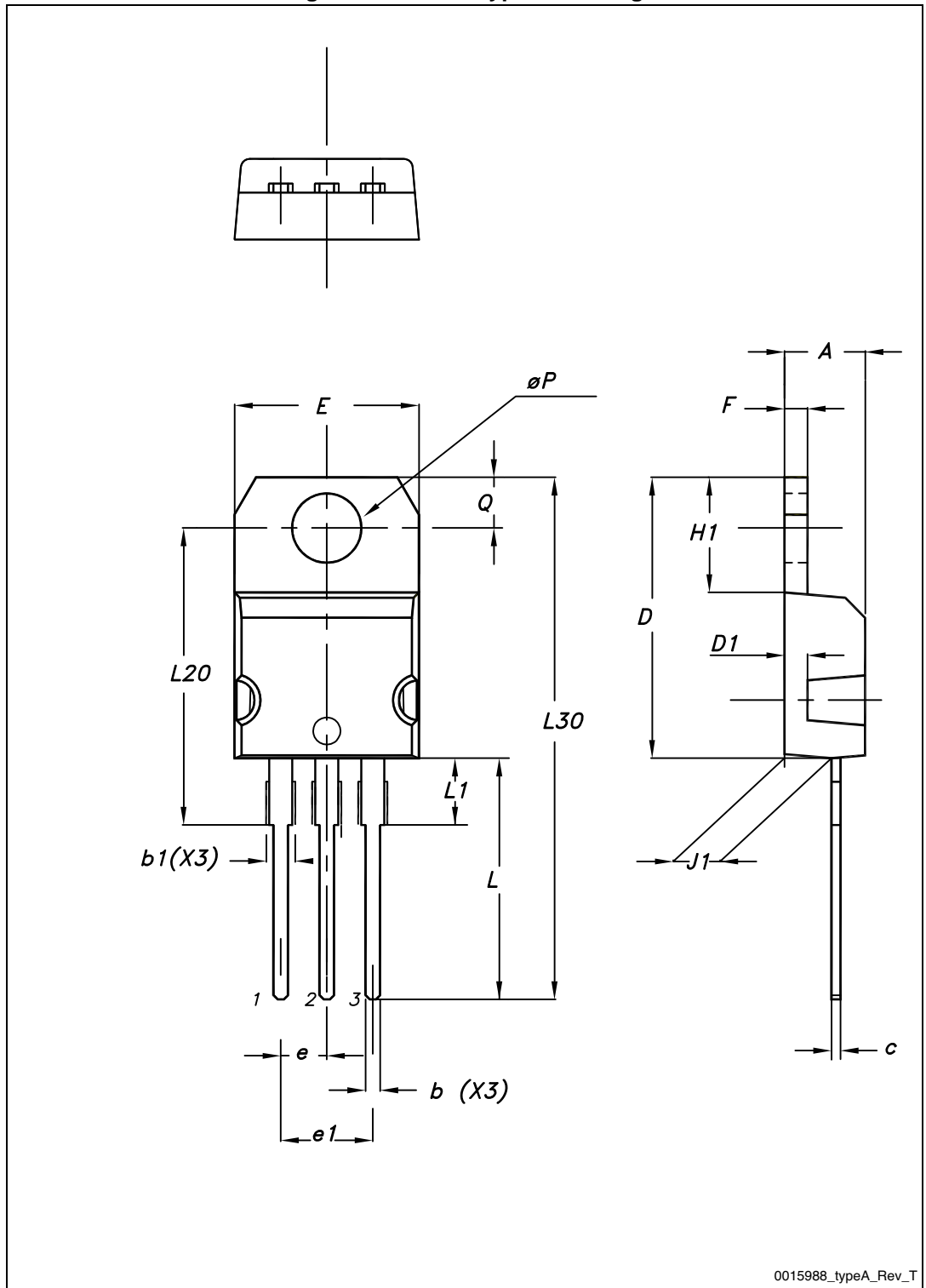


Figure 27. TO-220 type A drawing



0015988\_typeA\_Rev\_T



Table 11. TO-220 type A mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.70  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10    |       | 10.40 |
| e    | 2.40  |       | 2.70  |
| e1   | 4.95  |       | 5.15  |
| F    | 1.23  |       | 1.32  |
| H1   | 6.20  |       | 6.60  |
| J1   | 2.40  |       | 2.72  |
| L    | 13    |       | 14    |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| ØP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

Figure 28. TO-247 drawing

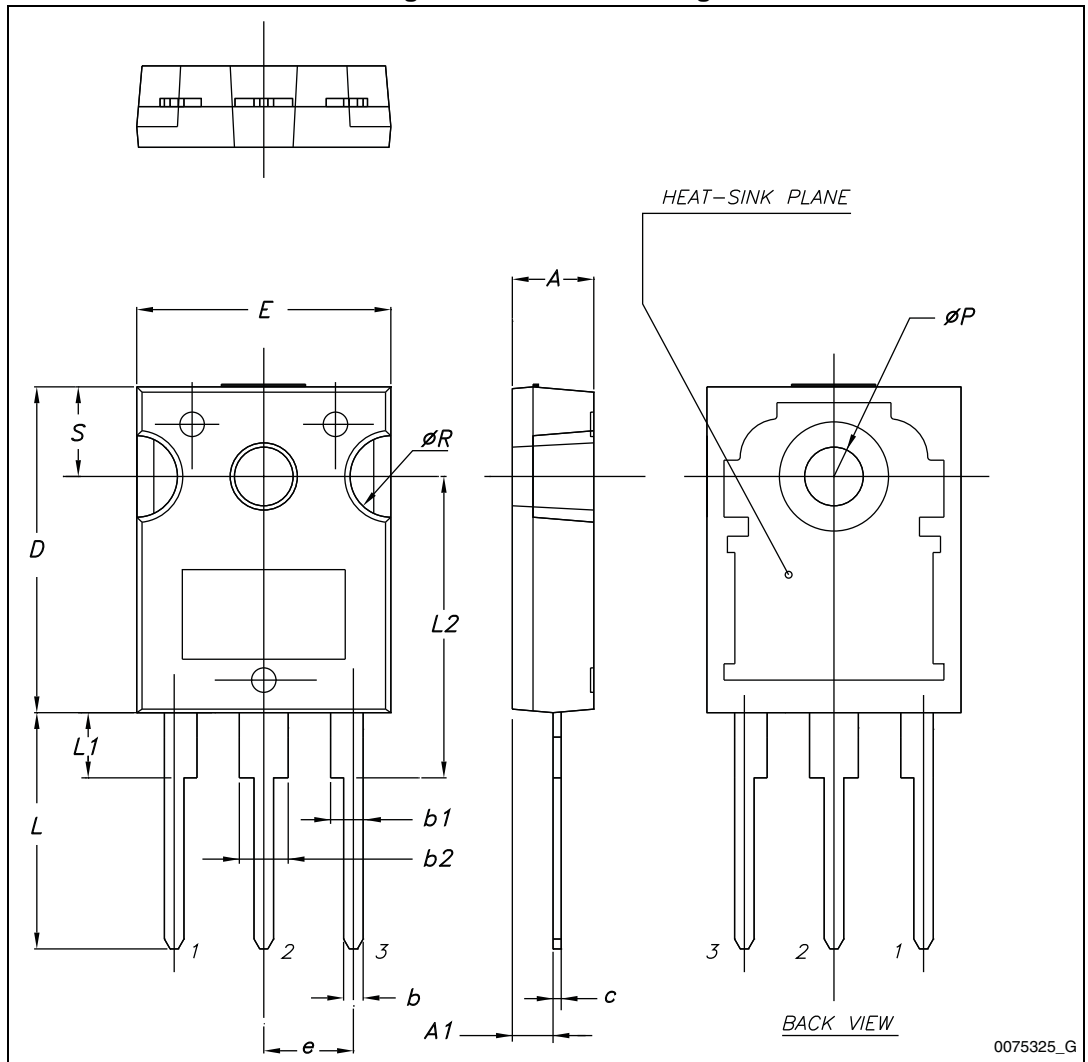


Table 12. TO-247 mechanical data

| Dim. | mm.   |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.85  |       | 5.15  |
| A1   | 2.20  |       | 2.60  |
| b    | 1.0   |       | 1.40  |
| b1   | 2.0   |       | 2.40  |
| b2   | 3.0   |       | 3.40  |
| c    | 0.40  |       | 0.80  |
| D    | 19.85 |       | 20.15 |
| E    | 15.45 |       | 15.75 |
| e    | 5.30  | 5.45  | 5.60  |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| ØP   | 3.55  |       | 3.65  |
| ØR   | 4.50  |       | 5.50  |
| S    | 5.30  | 5.50  | 5.70  |

# 5 Packaging mechanical data

Figure 29. Tape

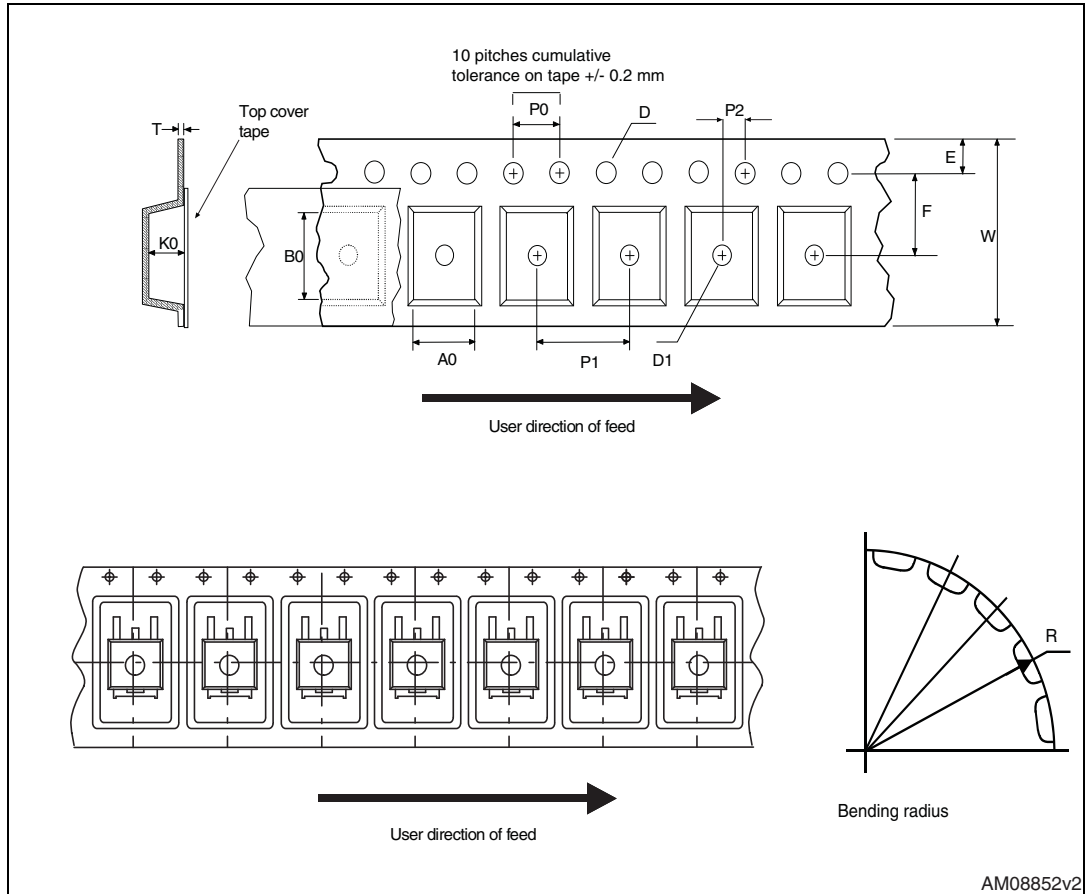


Figure 30. Reel

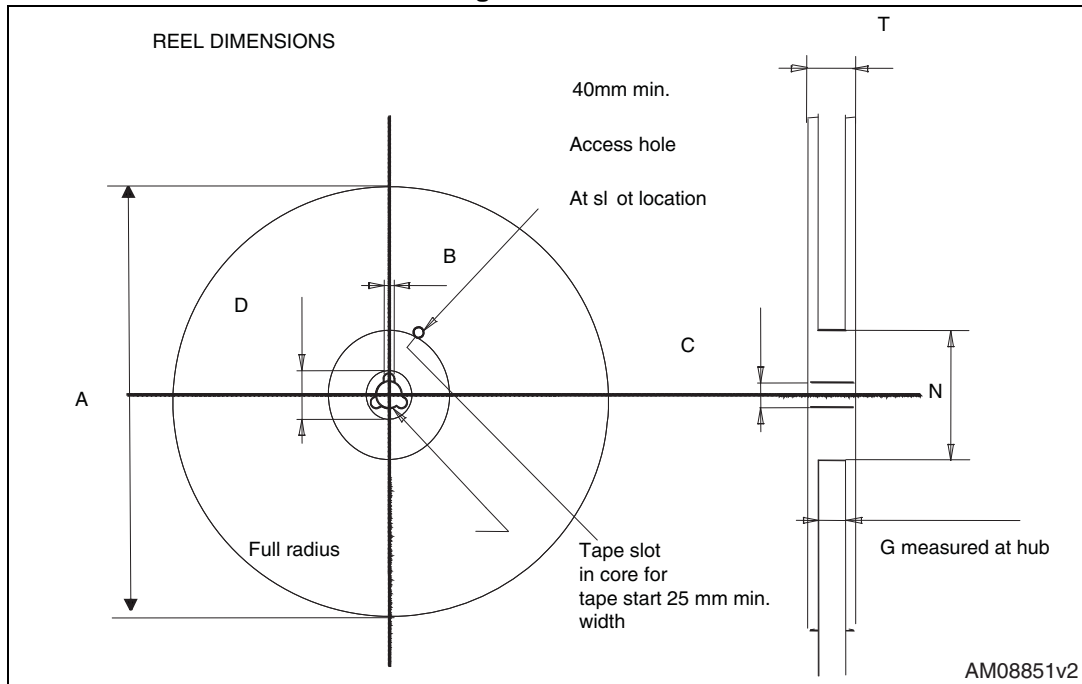


Table 13. H<sup>2</sup>PAK-2 tape and reel mechanical data

| 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 |      |          |      |

## 6 Revision history

**Table 14. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12-Jan-2007 | 1        | First release                                                                                                                                                                                                                                                                                                                                                                       |
| 17-Apr-2007 | 2        | Added new value on <a href="#">Table 6</a> .                                                                                                                                                                                                                                                                                                                                        |
| 14-May-2007 | 3        | The document has been reformatted                                                                                                                                                                                                                                                                                                                                                   |
| 29-Aug-2007 | 4        | $R_{DS(on)}$ value changed, updated <a href="#">Figure 15</a>                                                                                                                                                                                                                                                                                                                       |
| 09-Apr-2008 | 5        | Added new package: TO-3PF                                                                                                                                                                                                                                                                                                                                                           |
| 13-Feb-2009 | 6        | Added $P_{TOT}$ value for TO-3PF ( <a href="#">Table 2: Absolute maximum ratings</a> )                                                                                                                                                                                                                                                                                              |
| 01-Dec-2009 | 7        | <ul style="list-style-type: none"> <li>– Document status promoted from preliminary data to datasheet</li> <li>– Removed TO-220FH package and mechanical data</li> </ul>                                                                                                                                                                                                             |
| 10-Dec-2009 | 8        | Corrected $V_{ISO}$ value in <a href="#">Table 2: Absolute maximum ratings</a>                                                                                                                                                                                                                                                                                                      |
| 29-Jun-2010 | 9        | Corrected unit in <a href="#">Table 3</a> .                                                                                                                                                                                                                                                                                                                                         |
| 08-Feb-2013 | 10       | <ul style="list-style-type: none"> <li>– Minor text changes</li> <li>– Modified: <a href="#">Table 3</a></li> <li>– Changed: <a href="#">Figure 1</a></li> <li>– Added: H<sup>2</sup>PAK-2 package</li> </ul>                                                                                                                                                                       |
| 18-Feb-2014 | 11       | <ul style="list-style-type: none"> <li>– Modified: <a href="#">Figure 1</a></li> <li>– Updated: <a href="#">Figure 18</a>, <a href="#">19</a>, <a href="#">20</a> and <a href="#">21</a></li> <li>– Updated: <a href="#">Figure 27</a> and <a href="#">Table 11</a></li> <li>– Updated: <a href="#">Section 4: Package mechanical data</a></li> <li>– Minor text changes</li> </ul> |

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