



# STD8NM60ND, STF8NM60ND STP8NM60ND, STU8NM60ND

N-channel 600 V, 0.59  $\Omega$  , 7 A, FDmesh™ II Power MOSFET  
TO-220, TO-220FP, IPAK, DPAK

## Features

| Type       | V <sub>DSS</sub><br>(@T <sub>jmax</sub> ) | R <sub>DS(on)</sub><br>max | I <sub>D</sub>     |
|------------|---|----------------------------|--------------------|
| STD8NM60ND | 650 V                                     | < 0.70 $\Omega$            | 7 A                |
| STF8NM60ND | 650 V                                     | < 0.70 $\Omega$            | 7 A                |
| STP8NM60ND | 650 V                                     | < 0.70 $\Omega$            | 7 A <sup>(1)</sup> |
| STU8NM60ND | 650 V                                     | < 0.70 $\Omega$            | 7 A                |

1. Limited only by maximum temperature allowed

- The worldwide best R<sub>DS(on)</sub>\* area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities

## Application

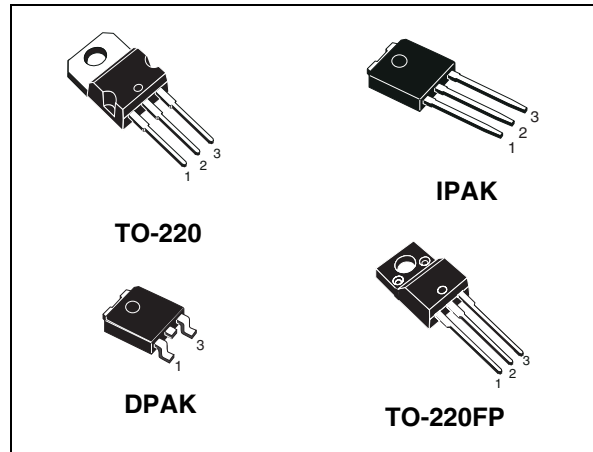
- Switching applications

## Description

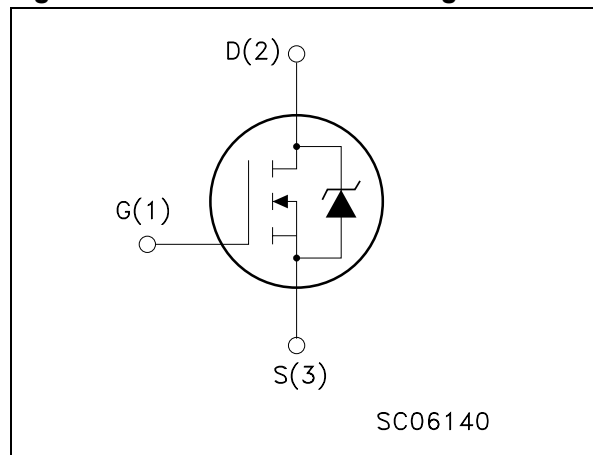
The FDmesh™ II series belongs to the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout and associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. Strongly recommended for bridge topologies, in ZVS phase-shift converters.

**Table 1. Device summary**

| Order codes | Marking | Package  | Packaging     |
|-------------|---------|----------|---------------|
| STD8NM60ND  | 8NM60ND | DPAK     | Tape and reel |
| STF8NM60ND  | 8NM60ND | TO-220FP | Tube          |
| STP8NM60ND  | 8NM60ND | TO-220   | Tube          |
| STU8NM60ND  | 8NM60ND | IPAK     | Tube          |



**Figure 1. Internal schematic diagram**



## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter  | Value      |      |                    |          | Unit             |
|----------------|--|------------|------|--------------------|----------|------------------|
|                |  | TO-220     | DPAK | IPAK               | TO-220FP |                  |
| $V_{DS}$       | Drain-source voltage ( $V_{GS} = 0$ )  | 600        |      |                    |          | V                |
| $V_{GS}$       | Gate-source voltage  | $\pm 30$   |      |                    |          | V                |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$   | 7          |      | 7 <sup>(1)</sup>   |          | A                |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$  | 4.4        |      | 4.4 <sup>(1)</sup> |          | A                |
| $I_{DM}^{(2)}$ | Drain current (pulsed)   | 28         |      | 28 <sup>(1)</sup>  |          | A                |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$  | 70         |      | 25                 |          | W                |
| $V_{ISO}$      | Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}; T_C = 25\text{ }^\circ\text{C}$ ) | 2500       |      |                    |          | V                |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope  | 40         |      |                    |          | V/ns             |
| $T_{stg}$      | Storage temperature  | -55 to 150 |      |                    |          | $^\circ\text{C}$ |
| $T_j$          | Max. operating junction temperature  | 150        |      |                    |          | $^\circ\text{C}$ |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- $I_{SD} \leq 7\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol         | Parameter                                      | Value  |      |      |          | Unit                      |
|----------------|--|--------|------|------|----------|---------------------------|
|                |  | TO-220 | DPAK | IPAK | TO-220FP |                           |
| $R_{thj-case}$ | Thermal resistance junction-case               | 1.79   |      |      | 5        | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-amb                | 62.5   |      | 100  | 62.5     | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}$  | Thermal resistance junction-pcb                |        | 50   |      |          | $^\circ\text{C}/\text{W}$ |
| $T_l$          | Maximum lead temperature for soldering purpose | 300    |      |      |          | $^\circ\text{C}$          |

**Table 4. Avalanche characteristics**

| Symbol   | Parameter  | Max value | Unit |
|----------|--|-----------|------|
| $I_{AS}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)                                   | 2.5       | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ ) | 200       | mJ   |

## 2 Electrical characteristics

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

**Table 5. On/off states**

| Symbol        | Parameter  | Test conditions  | Min. | Typ. | Max.      | Unit                           |
|---------------|--|--|------|------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$   | 600  |      |           | V                              |
| $dv/dt^{(1)}$ | Drain-source voltage slope                       | $V_{DD} = 480\text{ V}$ , $I_D = 7\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$               |      | 45   |           | V/ns                           |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating}$ ,<br>$V_{DS} = \text{Max rating}$ , $T_c = 125\text{ °C}$ |      |      | 1<br>100  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$   |      |      | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                     | 3    | 4    | 5         | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 3.5\text{ A}$  |      | 0.59 | 0.70      | $\Omega$                       |

1. Characteristics value at turn off on inductive load

**Table 6. Dynamic**

| Symbol                              | Parameter   | Test conditions  | Min. | Typ.           | Max. | Unit           |
|-------------------------------------|---|--|------|----------------|------|----------------|
| $g_{fs}^{(1)}$                      | Forward transconductance  | $V_{DS} = 15\text{ V}$ , $I_D = 5\text{ A}$  |      | 7.5            |      | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$                                 |      | 560<br>37<br>4 |      | pF<br>pF<br>pF |
| $C_{oss\text{ eq.}}^{(2)}$          | Equivalent output capacitance   | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }480\text{ V}$   |      | 90             |      | pF             |
| $R_G$                               | Gate input resistance   | $f = 1\text{ MHz}$ Gate DC Bias = 0<br>Test Signal Level = 20 mV<br>Open Drain             |      | 6              |      | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 480\text{ V}$ , $I_D = 7\text{ A}$<br>$V_{GS} = 10\text{ V}$<br><i>Figure 19</i> |      | 22<br>4<br>13  |      | nC<br>nC<br>nC |

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

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

**Table 7. Switching times**

| Symbol       | Parameter           | Test conditions                                | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 7\text{ A}$ , |      | 9    |      | ns   |
| $t_r$        | Rise time           | $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$   |      | 22   |      | ns   |
| $t_{d(off)}$ | Turn-off delay time | <a href="#">Figure 18</a> ,                    |      | 37   |      | ns   |
| $t_f$        | Fall time           | <a href="#">Figure 23</a>                      |      | 22   |      | ns   |

**Table 8. Source drain diode**

| Symbol          | Parameter                     | Test conditions                              | Min. | Typ. | Max. | Unit    |
|-----------------|-------------------------------|--|------|------|------|---------|
| $I_{SD}$        | Source-drain current          |  |      |      | 7    | A       |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  |      |      | 28   | A       |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 7\text{ A}$ , $V_{GS} = 0$         |      |      | 1.3  | V       |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 7\text{ A}$ , $di/dt = 100$        |      | 120  |      | ns      |
| $Q_{rr}$        | Reverse recovery charge       | $A/\mu s$ , $V_{DD} = 30\text{ V}$ ,         |      | 0.49 |      | $\mu C$ |
| $I_{RRM}$       | Reverse recovery current      | <a href="#">Figure 20</a>                    |      | 8    |      | A       |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 7\text{ A}$ ,                      |      | 170  |      | ns      |
| $Q_{rr}$        | Reverse recovery charge       | $di/dt = 100\text{ A}/\mu s$ ,               |      | 0.75 |      | $\mu C$ |
| $I_{RRM}$       | Reverse recovery current      | $V_{DD} = 30\text{ V}$ , $T_J = 150^\circ C$ |      | 9    |      | A       |

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration = 300  $\mu s$ , duty cycle 1.5%

## 2.1 Electrical characteristics

Figure 2. Safe operating area for TO-220

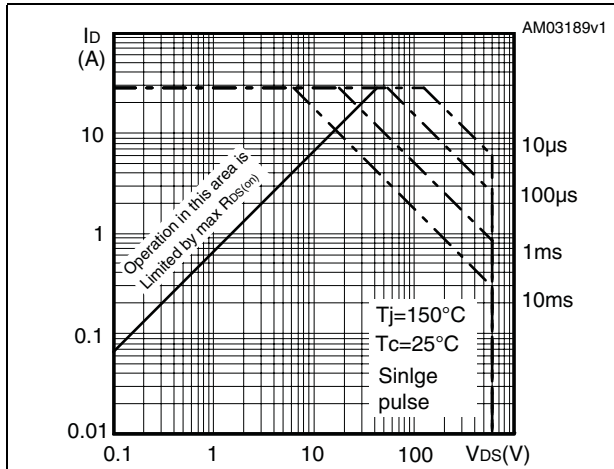


Figure 3. Thermal impedance for TO-220

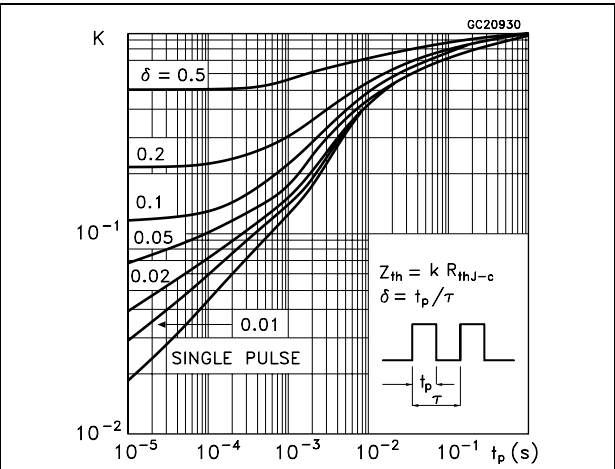


Figure 4. Safe operating area for DPAK, IPAK

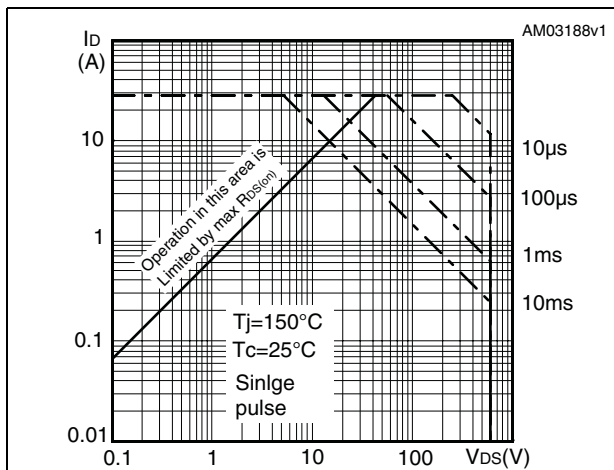


Figure 5. Thermal impedance for DPAK, IPAK

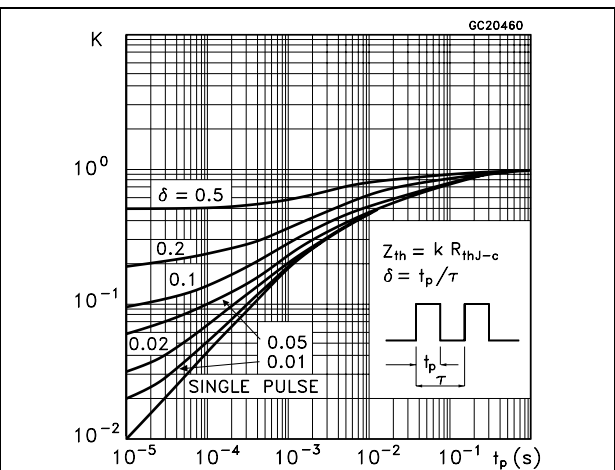


Figure 6. Safe operating area for TO-220FP

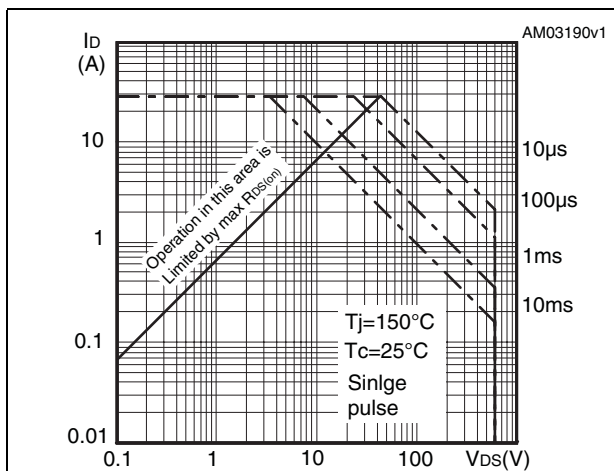


Figure 7. Thermal impedance for TO-220FP

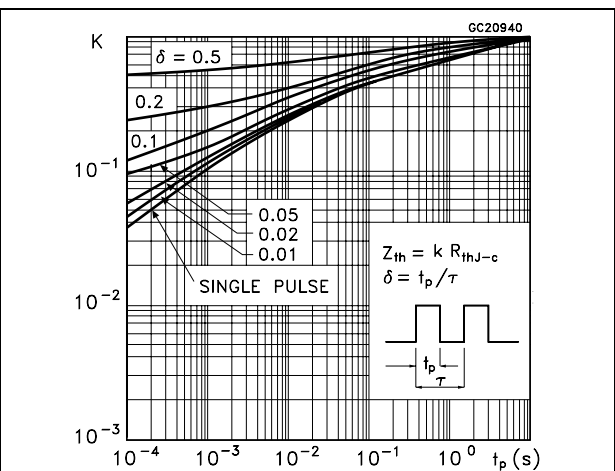


Figure 8. Output characteristics

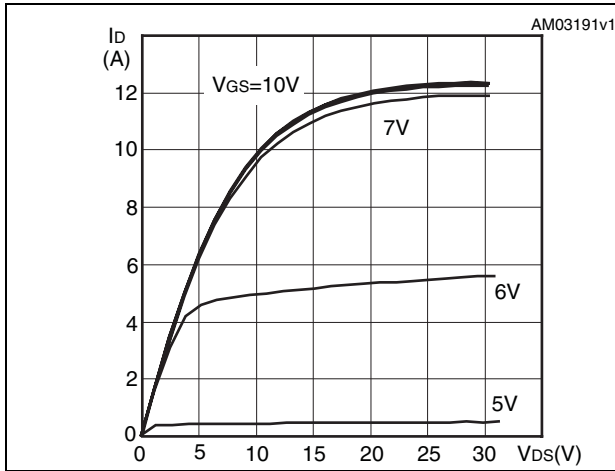


Figure 9. Transfer characteristics

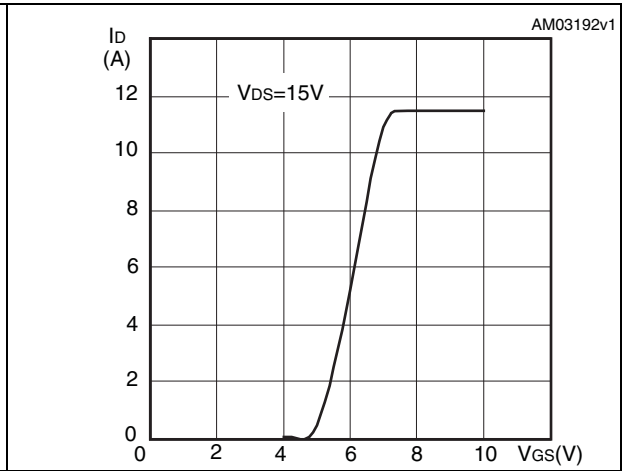


Figure 10. Transconductance

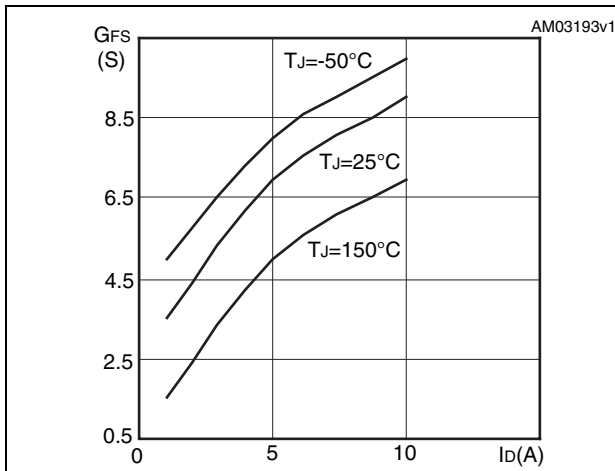


Figure 11. Static-drain source on resistance

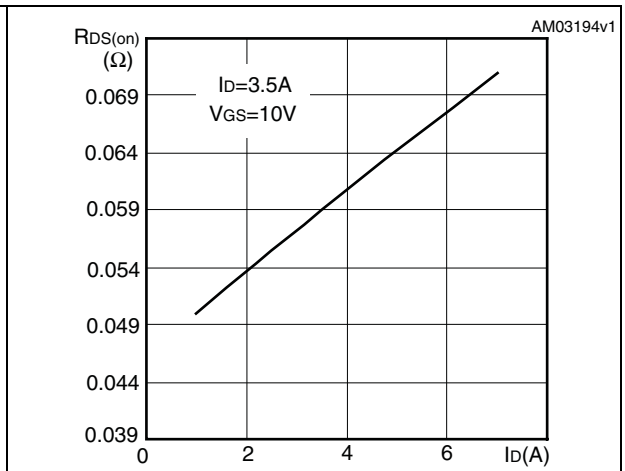


Figure 12. Gate charge vs gate-source voltage Figure 13. Capacitance variations

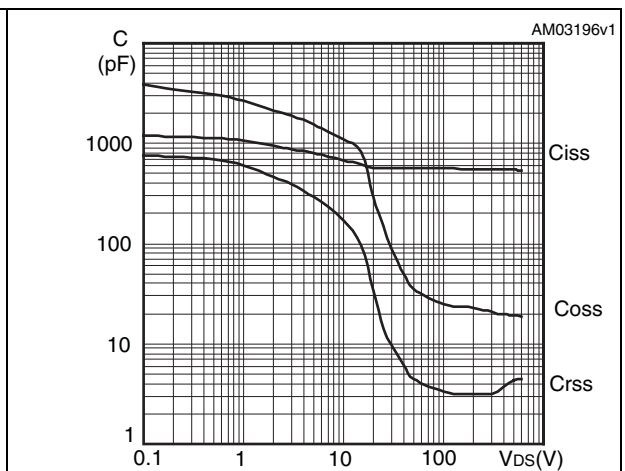
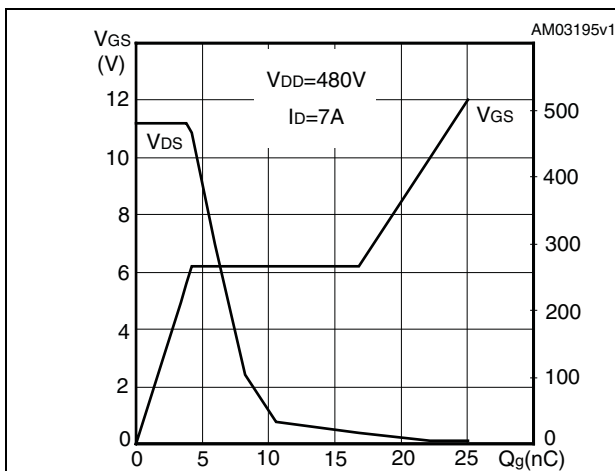


Figure 14. Normalized gate threshold voltage vs temperature

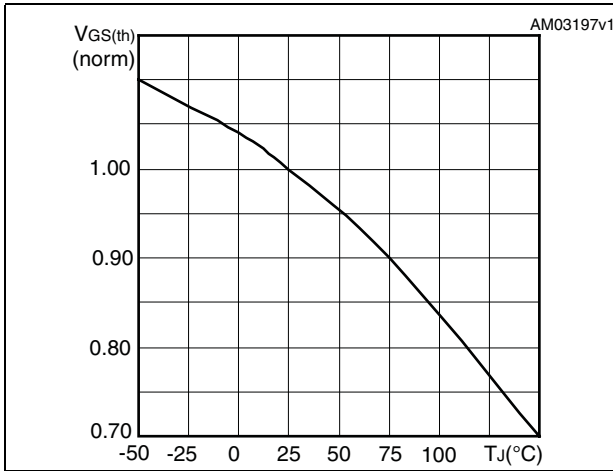


Figure 15. Normalized on resistance vs temperature

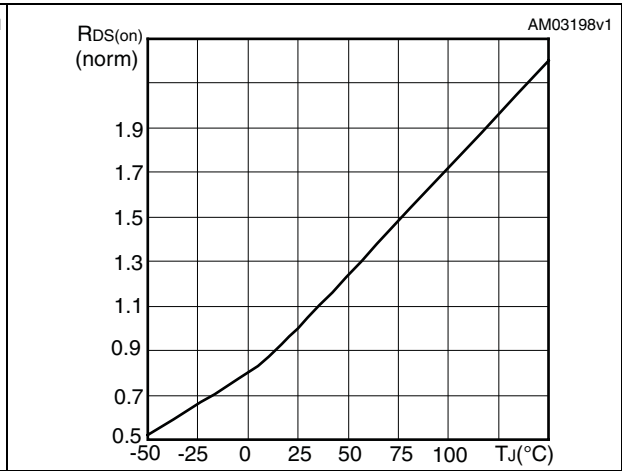


Figure 16. Source-drain diode forward characteristics

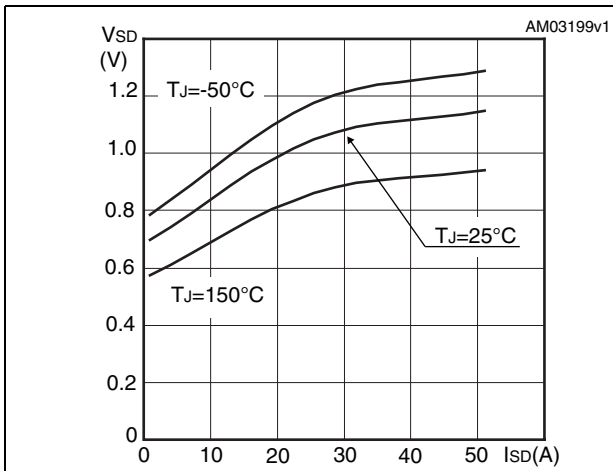
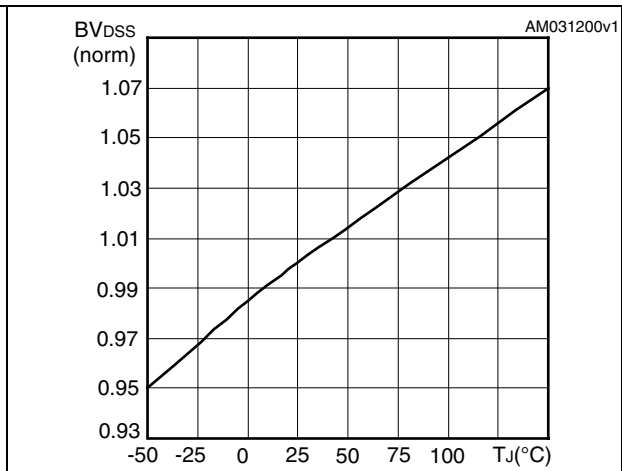


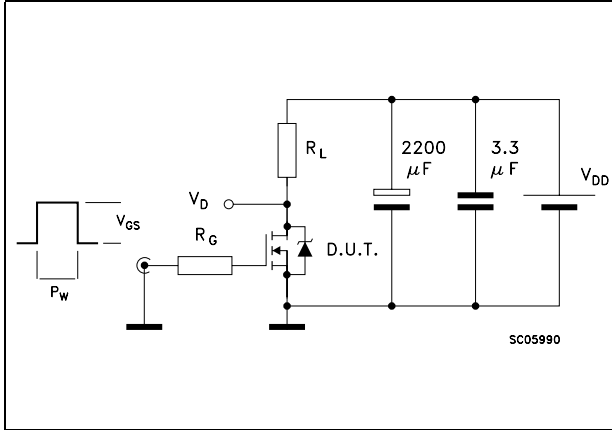
Figure 17. Normalized BV<sub>DSS</sub> vs temperature



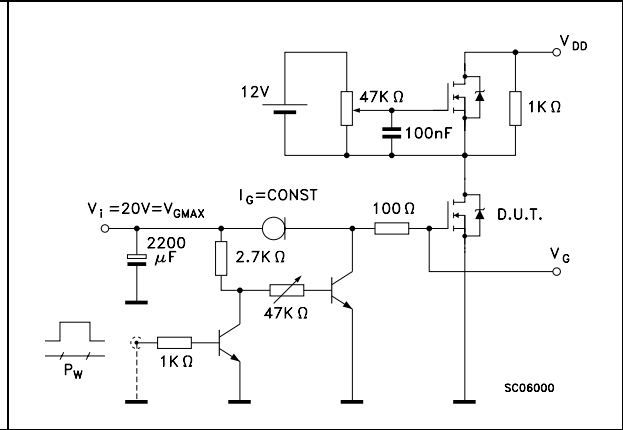


### 3 Test circuits

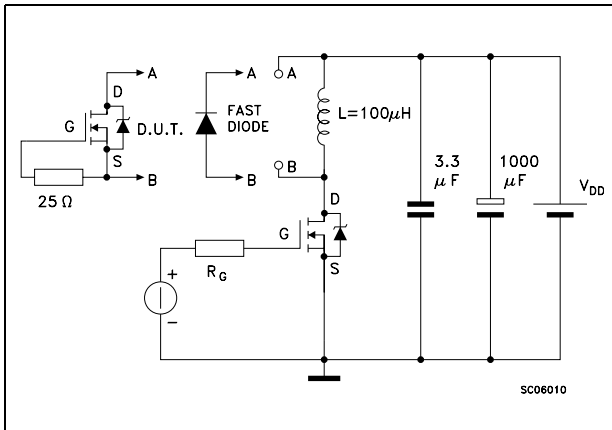
**Figure 18. Switching times test circuit for resistive load**



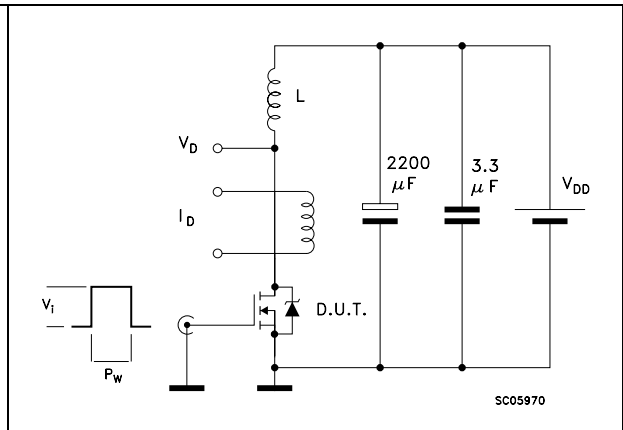
**Figure 19. Gate charge test circuit**



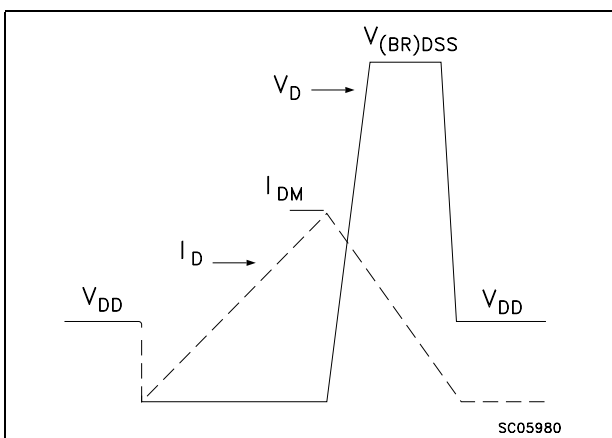
**Figure 20. Test circuit for inductive load switching and diode recovery times**



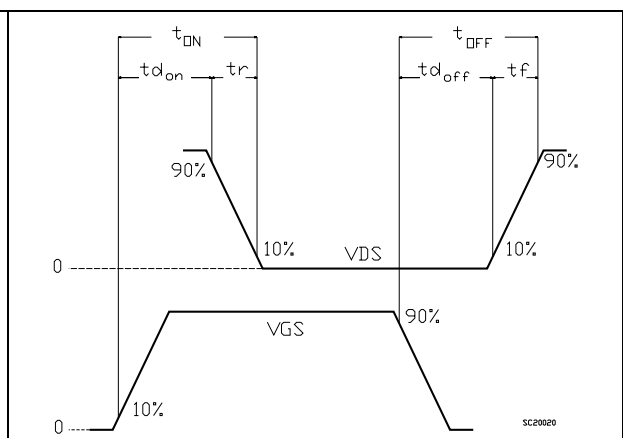
**Figure 21. Unclamped inductive load test circuit**



**Figure 22. Unclamped inductive waveform**



**Figure 23. Switching time waveform**

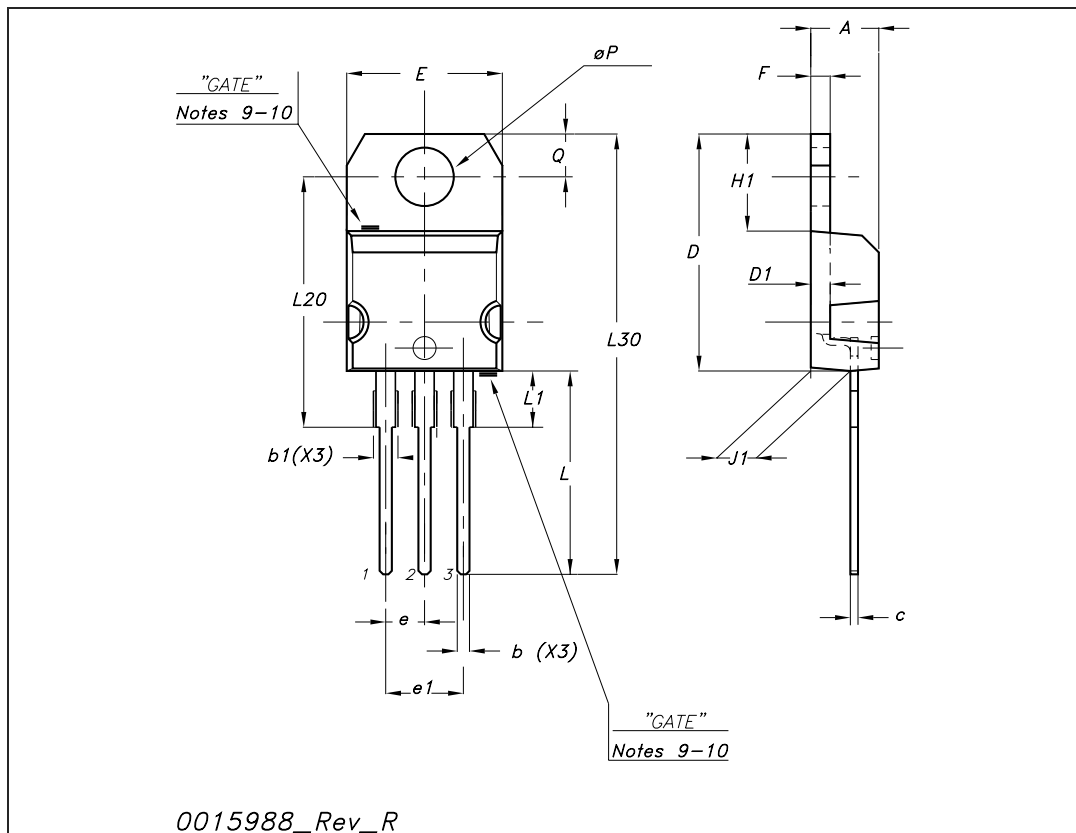


## 4 Package mechanical data

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.

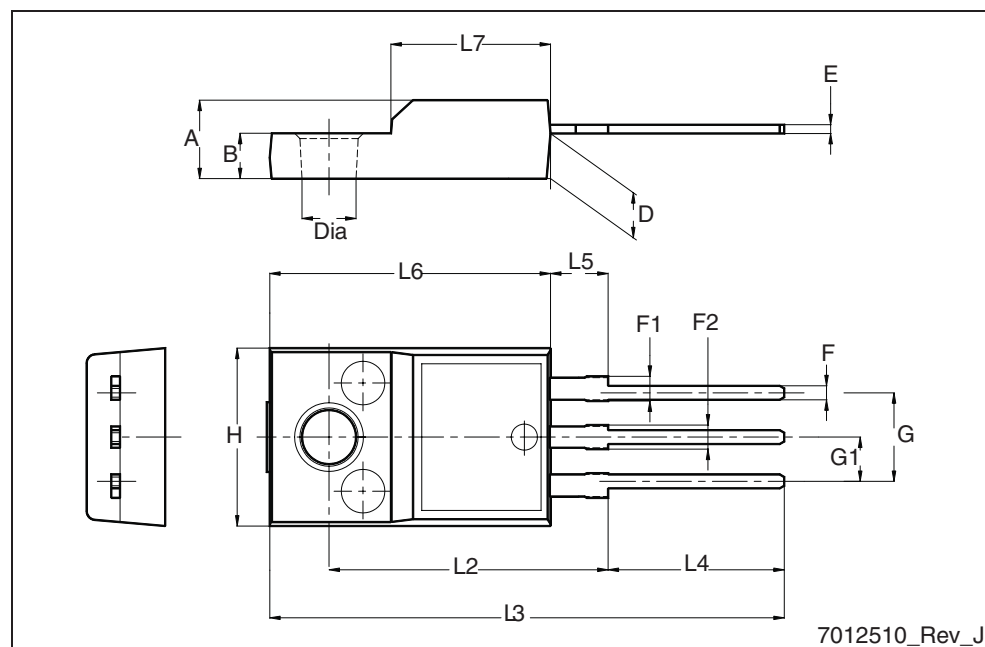
TO-220 mechanical data

| Dim | mm    |       |       | inch  |       |       |
|-----|-------|-------|-------|-------|-------|-------|
|     | Min   | Typ   | Max   | Min   | Typ   | Max   |
| A   | 4.40  |       | 4.60  | 0.173 |       | 0.181 |
| b   | 0.61  |       | 0.88  | 0.024 |       | 0.034 |
| b1  | 1.14  |       | 1.70  | 0.044 |       | 0.066 |
| c   | 0.48  |       | 0.70  | 0.019 |       | 0.027 |
| D   | 15.25 |       | 15.75 | 0.6   |       | 0.62  |
| D1  |       | 1.27  |       |       | 0.050 |       |
| E   | 10    |       | 10.40 | 0.393 |       | 0.409 |
| e   | 2.40  |       | 2.70  | 0.094 |       | 0.106 |
| e1  | 4.95  |       | 5.15  | 0.194 |       | 0.202 |
| F   | 1.23  |       | 1.32  | 0.048 |       | 0.051 |
| H1  | 6.20  |       | 6.60  | 0.244 |       | 0.256 |
| J1  | 2.40  |       | 2.72  | 0.094 |       | 0.107 |
| L   | 13    |       | 14    | 0.511 |       | 0.551 |
| L1  | 3.50  |       | 3.93  | 0.137 |       | 0.154 |
| L20 |       | 16.40 |       |       | 0.645 |       |
| L30 |       | 28.90 |       |       | 1.137 |       |
| ∅P  | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q   | 2.65  |       | 2.95  | 0.104 |       | 0.116 |



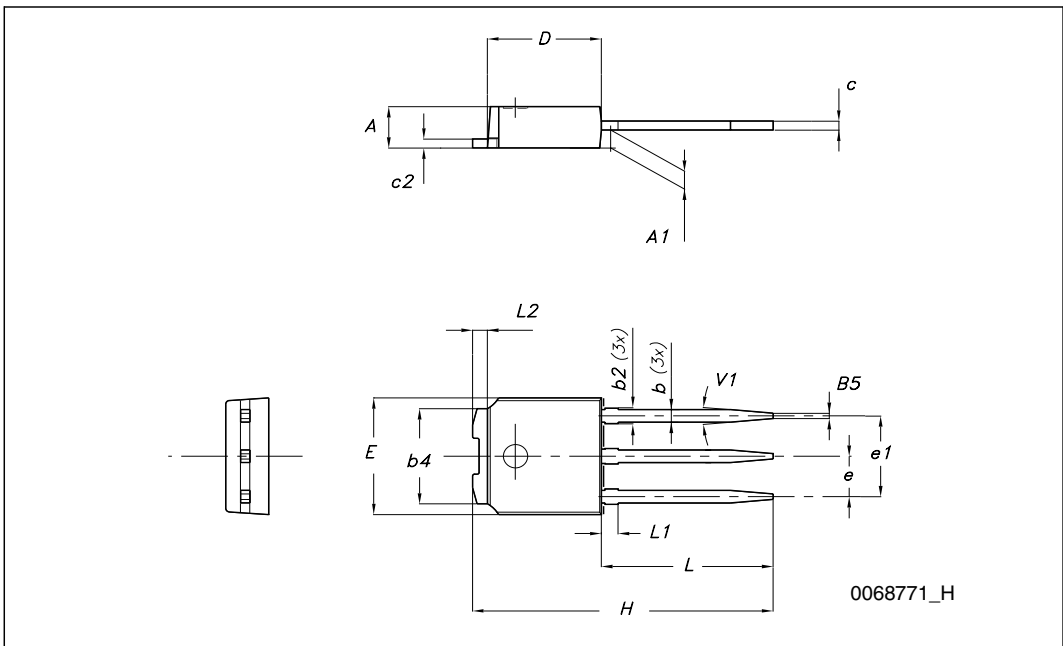
TO-220FP mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 4.4  |      | 4.6  |
| B    | 2.5  |      | 2.7  |
| D    | 2.5  |      | 2.75 |
| E    | 0.45 |      | 0.7  |
| F    | 0.75 |      | 1    |
| F1   | 1.15 |      | 1.70 |
| F2   | 1.15 |      | 1.5  |
| G    | 4.95 |      | 5.2  |
| G1   | 2.4  |      | 2.7  |
| H    | 10   |      | 10.4 |
| L2   |      | 16   |      |
| L3   | 28.6 |      | 30.6 |
| L4   | 9.8  |      | 10.6 |
| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Dia  | 3    |      | 3.2  |



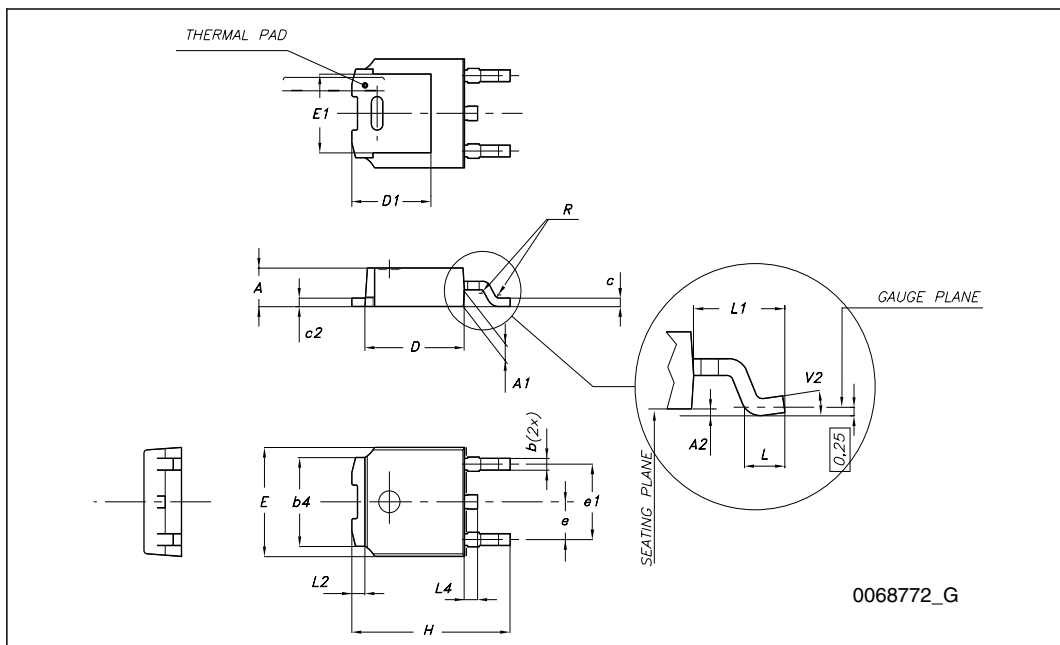
**TO-251 (IPAK) mechanical data**

| DIM. | mm.  |       |      |
|------|------|-------|------|
|      | min. | typ   | max. |
| A    | 2.20 |       | 2.40 |
| A1   | 0.90 |       | 1.10 |
| b    | 0.64 |       | 0.90 |
| b2   |      |       | 0.95 |
| b4   | 5.20 |       | 5.40 |
| c    | 0.45 |       | 0.60 |
| c2   | 0.48 |       | 0.60 |
| D    | 6.00 |       | 6.20 |
| E    | 6.40 |       | 6.60 |
| e    |      | 2.28  |      |
| e1   | 4.40 |       | 4.60 |
| H    |      | 16.10 |      |
| L    | 9.00 |       | 9.40 |
| (L1) | 0.80 |       | 1.20 |
| L2   |      | 0.80  |      |
| V1   |      | 10°   |      |



**TO-252 (DPAK) mechanical data**

| DIM. | mm.  |      |       |
|------|------|------|-------|
|      | min. | typ  | max.  |
| A    | 2.20 |      | 2.40  |
| A1   | 0.90 |      | 1.10  |
| A2   | 0.03 |      | 0.23  |
| b    | 0.64 |      | 0.90  |
| b4   | 5.20 |      | 5.40  |
| c    | 0.45 |      | 0.60  |
| c2   | 0.48 |      | 0.60  |
| D    | 6.00 |      | 6.20  |
| D1   |      | 5.10 |       |
| E    | 6.40 |      | 6.60  |
| E1   |      | 4.70 |       |
| e    |      | 2.28 |       |
| e1   | 4.40 |      | 4.60  |
| H    | 9.35 |      | 10.10 |
| L    | 1    |      |       |
| L1   |      | 2.80 |       |
| L2   |      | 0.80 |       |
| L4   | 0.60 |      | 1     |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |



# 5 Packaging mechanical data

## DPAK FOOTPRINT



## TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

G measured at hub

| DIM. | mm   |      | inch  |        |
|------|------|------|-------|--------|
|      | MIN. | MAX. | MIN.  | MAX.   |
| A    |      | 330  |       | 12.992 |
| B    | 1.5  |      | 0.059 |        |
| C    | 12.8 | 13.2 | 0.504 | 0.520  |
| D    | 20.2 |      | 0.795 |        |
| G    | 16.4 | 18.4 | 0.645 | 0.724  |
| N    | 50   |      | 1.968 |        |
| T    |      | 22.4 |       | 0.881  |

| BASE QTY | BULK QTY |
|----------|----------|
| 2500     | 2500     |

**TAPE MECHANICAL DATA**

| DIM. | mm   |      | inch  |       |
|------|------|------|-------|-------|
|      | MIN. | MAX. | MIN.  | MAX.  |
| A0   | 6.8  | 7    | 0.267 | 0.275 |
| B0   | 10.4 | 10.6 | 0.409 | 0.417 |
| B1   |      | 12.1 |       | 0.476 |
| D    | 1.5  | 1.6  | 0.059 | 0.063 |
| D1   | 1.5  |      | 0.059 |       |
| E    | 1.65 | 1.85 | 0.065 | 0.073 |
| F    | 7.4  | 7.6  | 0.291 | 0.299 |
| K0   | 2.55 | 2.75 | 0.100 | 0.108 |
| P0   | 3.9  | 4.1  | 0.153 | 0.161 |
| P1   | 7.9  | 8.1  | 0.311 | 0.319 |
| P2   | 1.9  | 2.1  | 0.075 | 0.082 |
| R    | 40   |      | 1.574 |       |
| W    | 15.7 | 16.3 | 0.618 | 0.641 |

TOP COVER TAPE

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

For machine ref. only including draft and radii concentric around B0

## 6 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes       |
|-------------|----------|---------------|
| 09-Feb-2009 | 1        | First release |



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