



# STB20NM60D

N-channel 600V - 0.26Ω - 20A - D<sup>2</sup>PAK  
FDmesh™ Power MOSFET

## General features

| Type       | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>w</sub> |
|------------|------------------|---------------------|----------------|----------------|
| STB20NM60D | 600V             | <0.29Ω              | 20A            | 45W            |

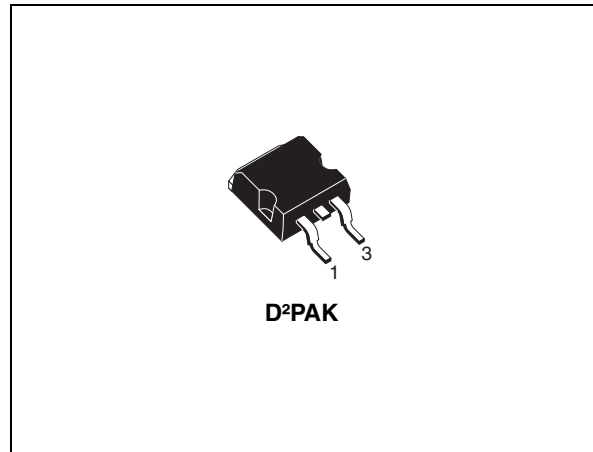
- High dv/dt and avalanche capabilities
- 100% Avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Tight process control and high manufacturing yields

## Description

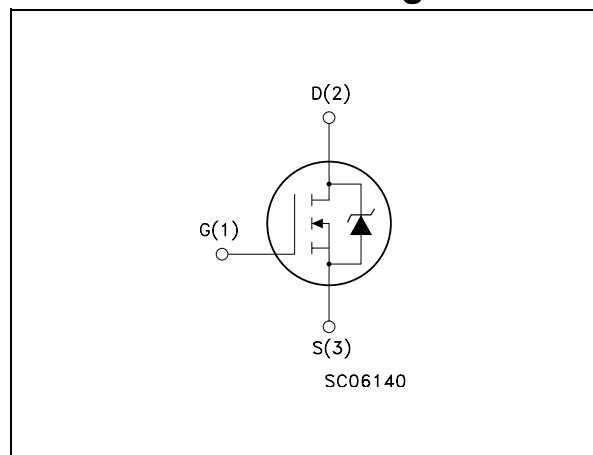
The FDmesh™ associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

## Applications

- Switching application



## Internal schematic diagram



## Order codes

| Part number | Marking  | Package            | Packaging   |
|-------------|----------|--------------------|-------------|
| STB20NM60D  | B20NM60D | D <sup>2</sup> PAK | Tape & reel |

# Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter   | Value       | Unit |
|----------------|---|-------------|------|
| $V_{DS}$       | Drain-source voltage ( $V_{GS} = 0$ )                   | 600         | V    |
| $V_{DGR}$      | Drain-gate voltage ( $R_{GS} = 20\text{ k}\Omega$ )     | 600         | V    |
| $V_{GS}$       | Gate- source voltage                                    | $\pm 30$    | V    |
| $I_D$          | Drain current (continuous) at $T_C = 25^\circ\text{C}$  | 20          | A    |
| $I_D$          | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 12.6        | A    |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                  | 80          | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25^\circ\text{C}$           | 192         | W    |
|                | Derating factor   | 1.20        | W/°C |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                       | 20          | V/ns |
| $T_j$          | Operating junction temperature                          | - 65 to 150 | °C   |
| $T_{stg}$      | Storage temperature                                     |             | °C   |

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 20\text{A}$ ,  $di/dt \leq 400\text{A}/\mu\text{s}$ ,  $V_{DD} = 80\%V_{(BR)DSS}$

**Table 2. Thermal resistance**

| Symbol    | Parameter                                      | Value | Unit |
|-----------|--|-------|------|
| Rthj-case | Thermal resistance junction-case Max           | 0.65  | °C/W |
| Rthj-amb  | Thermal resistance junction-ambient Max        | 62.5  | °C/W |
| $T_l$     | Maximum lead temperature for soldering purpose | 300   | °C   |

**Table 3. Avalanche data**

| Symbol   | Parameter  | Value | Unit |
|----------|--|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)                           | 10    | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 35\text{ V}$ ) | 700   | mJ   |

## 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol        | Parameter  | Test conditions  | Min | Typ  | Max           | Unit               |
|---------------|--|--|-----|------|---------------|--------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 250\mu A, V_{GS} = 0$   | 600 |      |               | V                  |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating}$<br>$V_{DS} = \text{Max rating}, T_C = 125^{\circ}C$ |     |      | 1<br>10       | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 30V$   |     |      | $\pm 10$<br>0 | $\mu A$            |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 250\mu A$  | 3   | 4    | 5             | V                  |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10V, I_D = 10A$  |     | 0.26 | 0.29          | $\Omega$           |

**Table 5. Dynamic**

| Symbol                      | Parameter                     | Test conditions  | Min | Typ  | Max | Unit     |
|-----------------------------|-------------------------------|--|-----|------|-----|----------|
| $g_{fs}^{(1)}$              | Forward transconductance      | $V_{DS} > I_{D(on)} \times R_{DS(on)max},$<br>$I_D = 10A$                    |     | 9    |     | S        |
| $C_{iss}$                   | Input capacitance             | $V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$                                |     | 1300 |     | pF       |
| $C_{oss}$                   | Output capacitance            |  |     | 500  |     | pF       |
| $C_{rss}$                   | Reverse transfer capacitance  |  |     | 35   |     | pF       |
| $C_{oss \text{ eq.}}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 480V$                                  |     | 190  |     | pF       |
| $R_G$                       | Gate input resistance         | $f=1 \text{ MHz}$ Gate DC Bias = 0<br>Test signal level = 20mV<br>open drain |     | 2.7  |     | $\Omega$ |
| $Q_g$                       | Total gate charge             | $V_{DD} = 480V, I_D = 20A,$<br>$V_{GS} = 10V$<br>(see Figure 13)             |     | 37   | 52  | nC       |
| $Q_{gs}$                    | Gate-source charge            |  |     | 10   |     | nC       |
| $Q_{gd}$                    | Gate-drain charge             |  |     | 17   |     | nC       |

1. Pulsed: Pulse duration = 300  $\mu s$ , 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%

**Table 6. Switching times**

| Symbol                          | Parameter   | Test conditions   | Min. | Typ.          | Max. | Unit           |
|---------------------------------|---|---|------|---------------|------|----------------|
| $t_{d(on)}$<br>$t_r$            | Turn-on delay time<br>Rise time                       | $V_{DD} = 300V, I_D = 10A$<br>$R_G = 4.7\Omega, V_{GS} = 10V$<br>(see Figure 12)  |      | 25<br>12      |      | ns<br>ns       |
| $t_{r(Voff)}$<br>$t_f$<br>$t_c$ | Off-voltage rise time<br>Fall time<br>Cross-over time | $V_{DD} = 480V, I_D = 20A,$<br>$R_G = 4.7\Omega, V_{GS} = 10V$<br>(see Figure 12) |      | 8<br>22<br>30 |      | ns<br>ns<br>ns |

**Table 7. Source drain diode**

| Symbol                            | Parameter  | Test conditions  | Min | Typ.              | Max      | Unit          |
|-----------------------------------|--|--|-----|-------------------|----------|---------------|
| $I_{SD}$<br>$I_{SDM}^{(1)}$       | Source-drain current<br>Source-drain current (pulsed)                        |  |     |                   | 20<br>80 | A<br>A        |
| $V_{SD}^{(2)}$                    | Forward on voltage   | $I_{SD} = 20A, V_{GS} = 0$   |     |                   | 1.5      | V             |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 20A, T_j = 25^\circ C$<br>$di/dt = 100A/\mu s, V_{DD} = 60V$<br>(see Figure 17)  |     | 240<br>1800<br>16 |          | ns<br>nC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 20A, T_j = 150^\circ C$<br>$di/dt = 100A/\mu s, V_{DD} = 60V$<br>(see Figure 17) |     | 396<br>2960<br>20 |          | ns<br>nC<br>A |

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

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

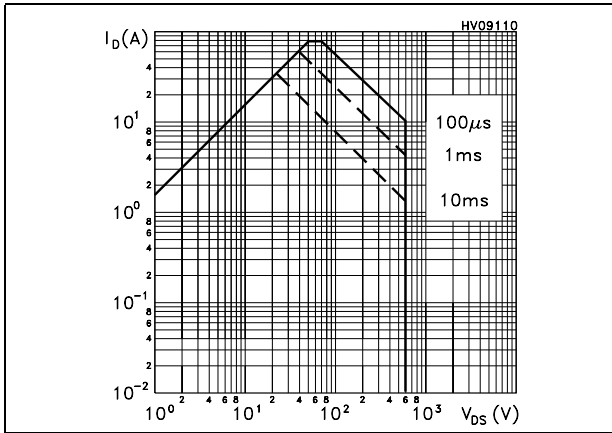


Figure 2. Thermal impedance

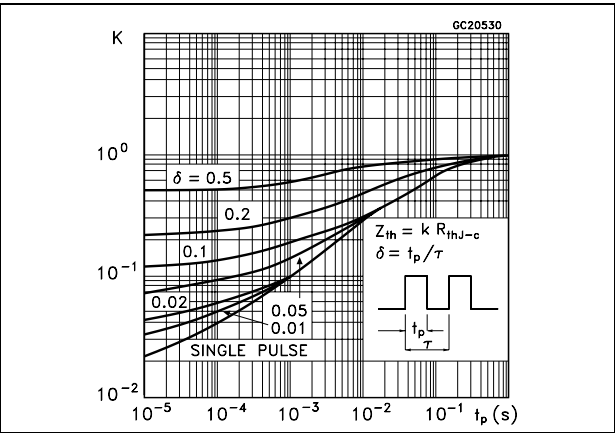


Figure 3. Output characteristics

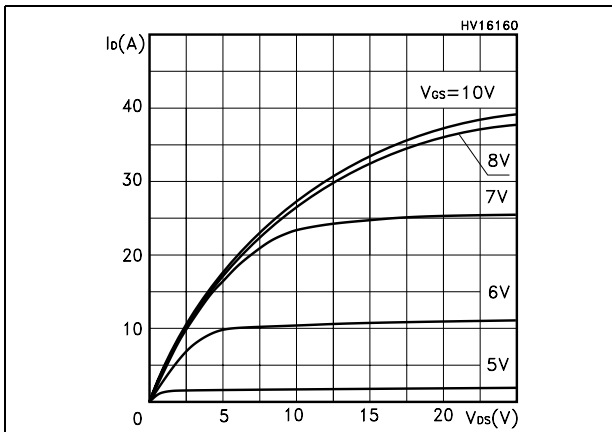


Figure 4. Transfer characteristics

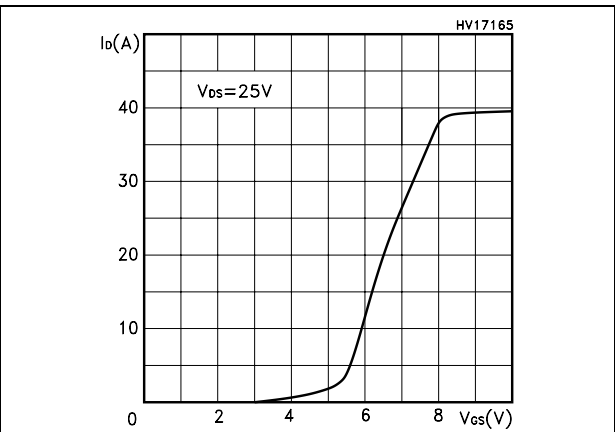


Figure 5. Transconductance

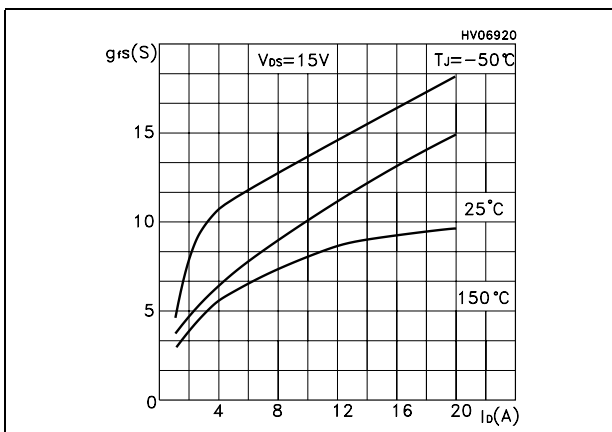


Figure 6. Static drain-source on resistance

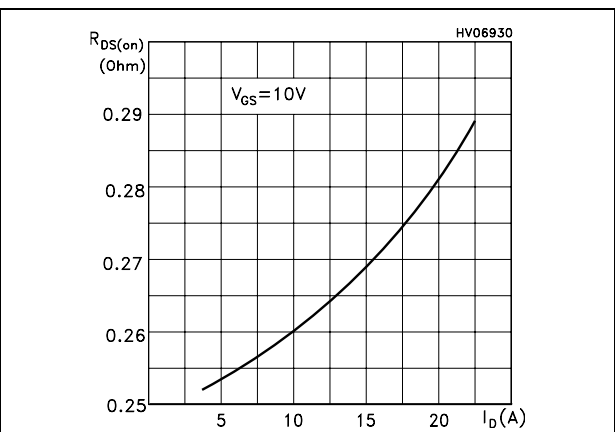


Figure 7. Gate charge vs gate-source voltage Figure 8. Capacitance variations

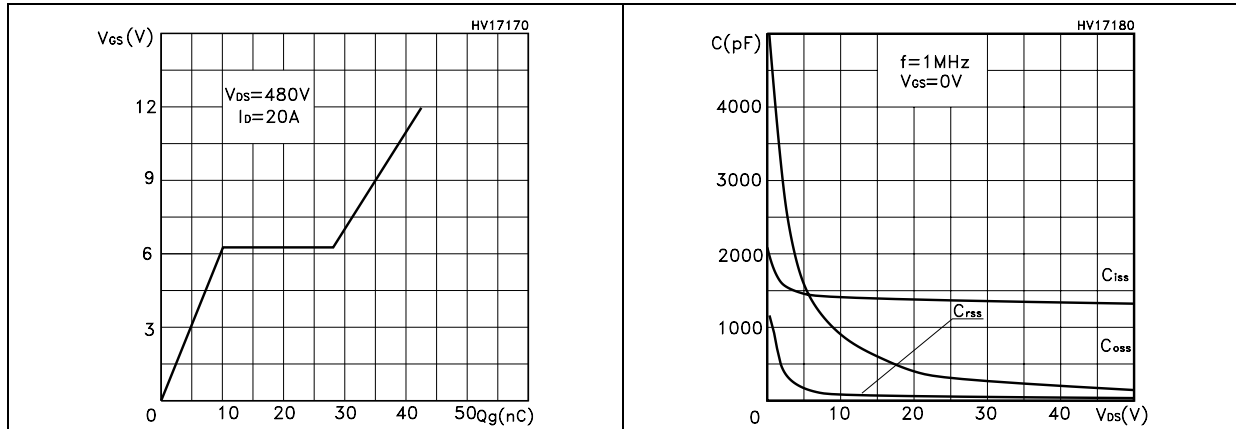


Figure 9. Normalized gate threshold voltage vs temperature Figure 10. Normalized on resistance vs temperature

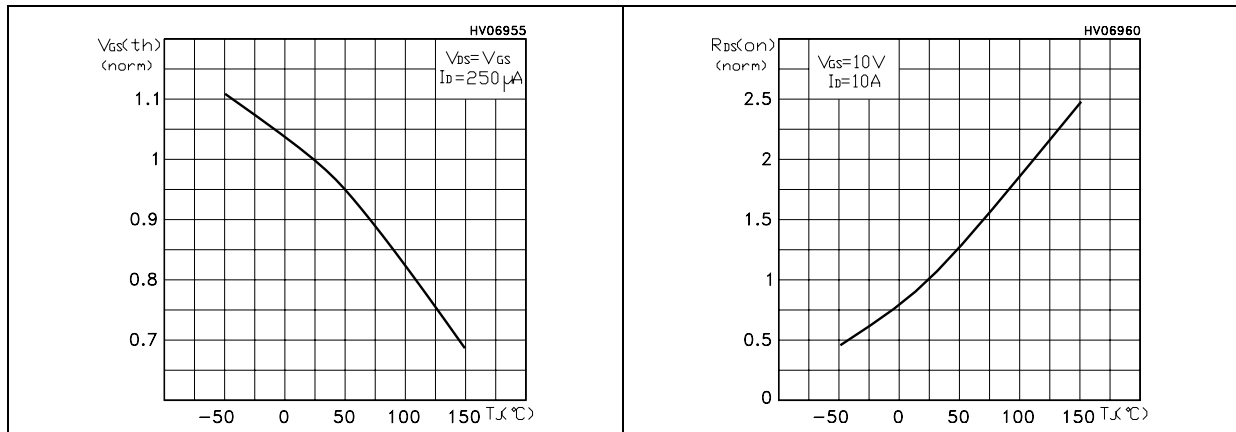
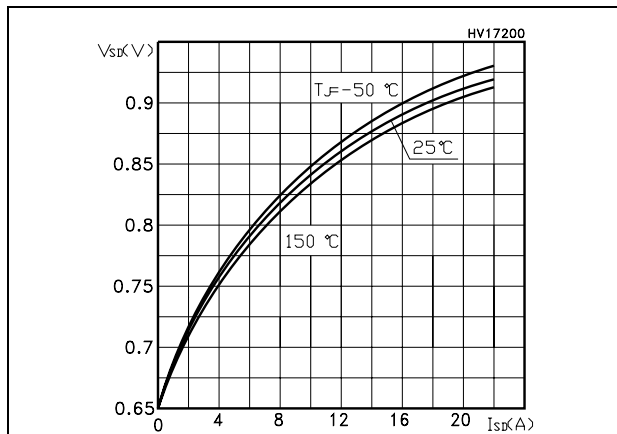


Figure 11. Source-drain diode forward characteristics



### 3 Test circuit

Figure 12. Switching times test circuit for resistive load



Figure 13. Gate charge test circuit

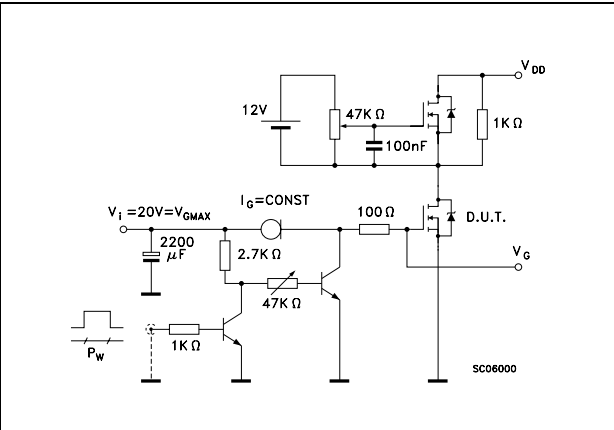


Figure 14. Test circuit for inductive load switching and diode recovery times



Figure 15. Unclamped inductive load test circuit

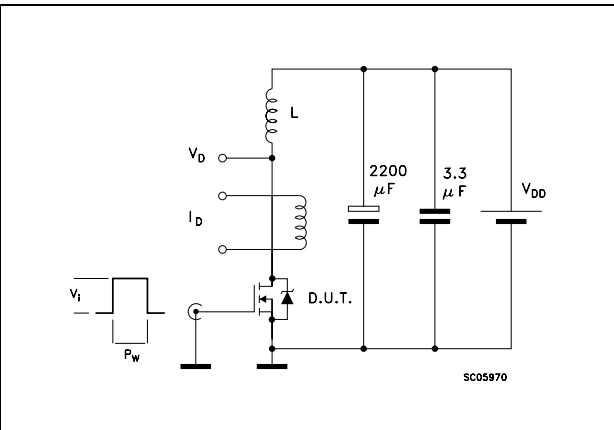
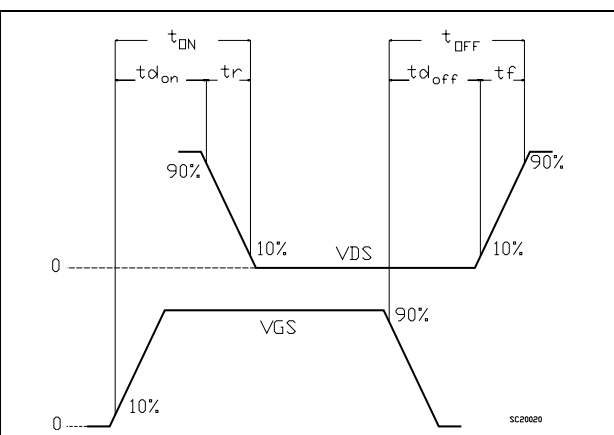


Figure 16. Unclamped inductive waveform



Figure 17. Switching time waveform



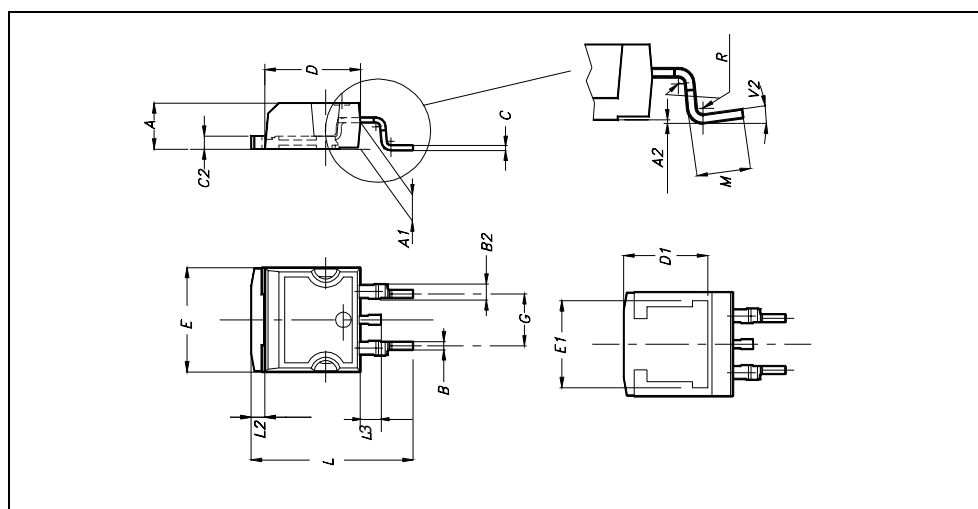


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

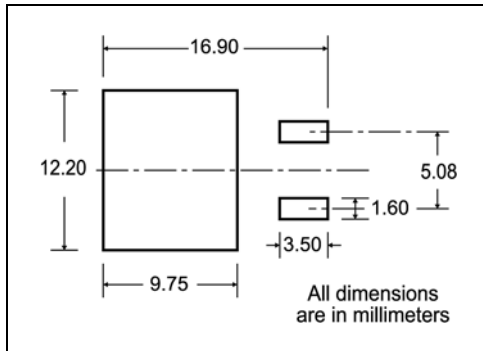
**D<sup>2</sup>PAK MECHANICAL DATA**

| DIM. | mm.  |     |       | inch  |       |       |
|------|------|-----|-------|-------|-------|-------|
|      | MIN. | TYP | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |     | 4.6   | 0.173 |       | 0.181 |
| A1   | 2.49 |     | 2.69  | 0.098 |       | 0.106 |
| A2   | 0.03 |     | 0.23  | 0.001 |       | 0.009 |
| B    | 0.7  |     | 0.93  | 0.027 |       | 0.036 |
| B2   | 1.14 |     | 1.7   | 0.044 |       | 0.067 |
| C    | 0.45 |     | 0.6   | 0.017 |       | 0.023 |
| C2   | 1.23 |     | 1.36  | 0.048 |       | 0.053 |
| D    | 8.95 |     | 9.35  | 0.352 |       | 0.368 |
| D1   |      | 8   |       |       | 0.315 |       |
| E    | 10   |     | 10.4  | 0.393 |       |       |
| E1   |      | 8.5 |       |       | 0.334 |       |
| G    | 4.88 |     | 5.28  | 0.192 |       | 0.208 |
| L    | 15   |     | 15.85 | 0.590 |       | 0.625 |
| L2   | 1.27 |     | 1.4   | 0.050 |       | 0.055 |
| L3   | 1.4  |     | 1.75  | 0.055 |       | 0.068 |
| M    | 2.4  |     | 3.2   | 0.094 |       | 0.126 |
| R    |      | 0.4 |       |       | 0.015 |       |
| V2   | 0°   |     | 4°    |       |       |       |



# 5 Packaging mechanical data

## D<sup>2</sup>PAK FOOTPRINT



## TAPE AND REEL SHIPMENT

**TAPE MECHANICAL DATA**

| DIM. | mm   |      | inch   |        |
|------|------|------|--------|--------|
|      | MIN. | MAX. | MIN.   | MAX.   |
| A0   | 10.5 | 10.7 | 0.413  | 0.421  |
| B0   | 15.7 | 15.9 | 0.618  | 0.626  |
| D    | 1.5  | 1.6  | 0.059  | 0.063  |
| D1   | 1.59 | 1.61 | 0.062  | 0.063  |
| E    | 1.65 | 1.85 | 0.065  | 0.073  |
| F    | 11.4 | 11.6 | 0.449  | 0.456  |
| K0   | 4.8  | 5.0  | 0.189  | 0.197  |
| P0   | 3.9  | 4.1  | 0.153  | 0.161  |
| P1   | 11.9 | 12.1 | 0.468  | 0.476  |
| P2   | 1.9  | 2.1  | 0.075  | 0.082  |
| R    | 50   |      | 1.574  |        |
| T    | 0.25 | 0.35 | 0.0098 | 0.0137 |
| W    | 23.7 | 24.3 | 0.933  | 0.956  |

**REEL MECHANICAL DATA**

| 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    | 24.4 | 26.4 | 0.960 | 1.039  |
| N    | 100  |      | 3.937 |        |
| T    |      | 30.4 |       | 1.197  |

| BASE QTY | BULK QTY |
|----------|----------|
| 1000     | 1000     |

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

\* on sales type

## 6 Revision history

**Table 8. Revision history**

| Date        | Revision | Changes       |
|-------------|----------|---------------|
| 08-Jun-2006 | 1        | First release |

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