



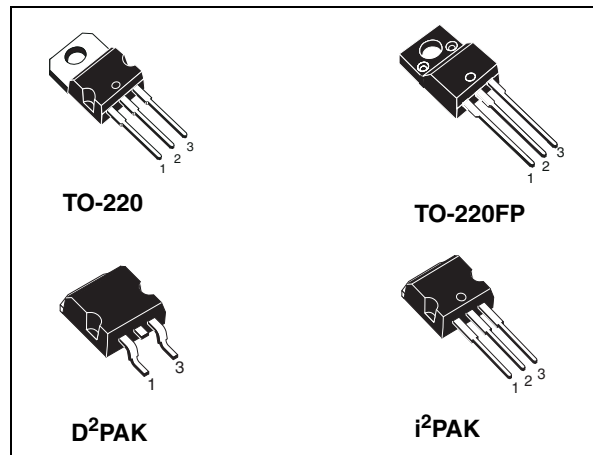
STP11NM60 - STP11NM60FP STB11NM60 - STB11NM60-1

N-channel 650V @ T_{Jmax} - 0.4Ω - 11A TO-220/FP/D²PAK/I²PAK
MDmesh™ Power MOSFET

General features

| Type | V_{DSS} (@ $T_J=T_{Jmax}$) | $R_{DS(on)}$ | I_D |
|-------------|----------------------------------|----------------|-------|
| STP11NM60 | 650V | <0.45 Ω | 11A |
| STP11NM60FP | 650V | <0.45 Ω | 11A |
| STB11NM60 | 650V | <0.45 Ω | 11A |
| STB11NM60-1 | 650V | <0.45 Ω | 11A |

- High dv/dt and avalanche capabilities
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance



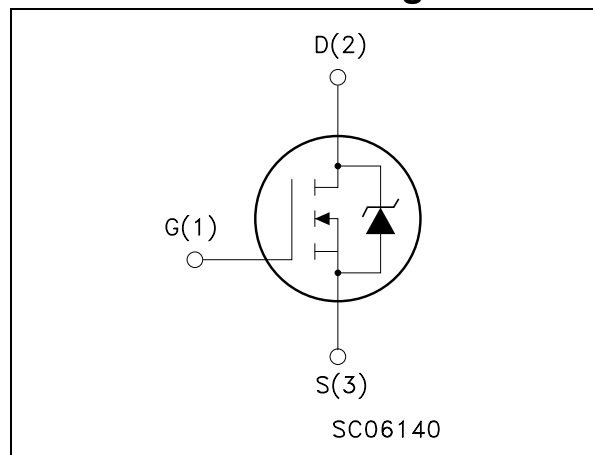
Description

The MDmesh™ is a new revolutionary MOSFET technology that associates the Multiple Drain process with the Company's PowerMESH™ horizontal layout. The resulting product has an outstanding low on-resistance, impressively high dv/dt and excellent avalanche characteristics. The adoption of the Company's proprietary strip technique yields overall dynamic performance that is significantly better than that of similar competition's products.

Applications

- Switching application

Internal schematic diagram



Order codes

| Part number | Marking | Package | Packaging |
|-------------|-----------|--------------------|-------------|
| STB11NM60T4 | B11NM60 | D ² PAK | Tape & reel |
| STB11NM60-1 | B11NM60-1 | I ² PAK | Tube |
| STP11NM60 | P11NM60 | TO-220 | Tube |
| STP11NM60FP | P11NM60FP | TO-220FP | Tube |

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1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|---|--|-------------------|------|
| | | TO-220/D ² PAK/I ² PAK | TO-220FP | |
| V _{GS} | Gate- source voltage | ±30 | | V |
| I _D | Drain current (continuous) at T _C = 25°C | 11 | 11 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C =100°C | 7 | 7 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 44 | 44 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25°C | 160 | 35 | W |
| | Derating Factor | 1.28 | 0.28 | W/°C |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 15 | | V/ns |
| V _{ISO} | Insulation withstand voltage (DC) | -- | 2500 | V |
| T _J | Operating junction temperature | -65 to 150 | | °C |
| T _{stg} | Storage temperature | 150 | | °C |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 11A, di/dt ≤ 400A/μs, V_{DD} ≤ V_{(BR)DSS}, T_J ≤ T_{JMAX}.

Table 2. Thermal data

| Symbol | Parameter | Value | | Unit |
|-----------------------|--|--|----------|------|
| | | TO-220/D ² PAK/I ² PAK | TO-220FP | |
| R _{thj-case} | Thermal resistance junction-case Max | 0.78 | 3.57 | °C/W |
| R _{thj-a} | Thermal resistance junction-ambient Max | 62.5 | | °C/W |
| T _I | Maximum lead temperature for soldering purpose | 300 | | °C |

Table 3. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|-----------------|---|-------|------|
| I _{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T _J Max) | 5.5 | A |
| E _{AS} | Single pulse avalanche energy (starting T _J =25°C, I _d =I _{ar} , V _{dd} =50V) | 350 | 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 ($V_{GS} = 0$) | $V_{DS} = 600 V$ $V_{DS} = 600 V, T_c = 125^{\circ}C$ | | | 1 10 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 30V$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 250 \mu A$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10V, I_D = 5.5A$ | | 0.4 | 0.45 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|---|--|------|-------------------|------|----------------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} > I_{D(on)} \times R_{DS(on)max},$ $I_D = 5.5A$ | | 5.2 | | S |
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 25V, f = 1 MHz, V_{GS} = 0$ | | 1000 230 25 | | pF pF pF |
| $C_{oss eq}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0V \text{ to } 480V$ | | 100 | | pF |
| R_G | Gate input resistance | $f = 1 MHz$ gate DC bias = 0 Test signal level = 20mV open drain | | 1.6 | | Ω |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 480V, I_D = 11A$ $V_{GS} = 10V$ (see Figure 15) | | 30 10 15 | | nC nC nC |

1. Pulsed: pulse duration=300 μs , duty cycle 1.5%

2. $C_{oss eq}$ 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 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------------------|---|---|------|---------------|------|----------------|
| $t_{d(on)}$ t_r | Turn-on delay time Rise time | $V_{DD}=300\text{ V}$, $I_D=5.5\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ (see Figure 17) | | 20 20 | | ns ns |
| $t_{r(Voff)}$ t_f t_c | Off-voltage rise time Fall time Cross-over time | $V_{DD}=480\text{ V}$, $I_D=11\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ (see Figure 17) | | 6 11 19 | | ns ns ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------------------------|--|--|-----|--------------------|-----|--------------------------|
| I_{SD} | Source-drain current | | | | 11 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 44 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=11\text{ A}$, $V_{GS}=0$ | | | 1.5 | V |
| t_{rr} Q_{rr} I_{RRM} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_{SD}=11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=100\text{ V}$, $T_j=25^\circ\text{C}$ (see Figure 16) | | 390 3.8 19.5 | | ns μC A |
| t_{rr} Q_{rr} I_{RRM} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_{SD}=11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=100\text{ V}$, $T_j=150^\circ\text{C}$ (see Figure 16) | | 570 5.7 20 | | ns μC A |

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration=300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220/D²PAK/I²PAK

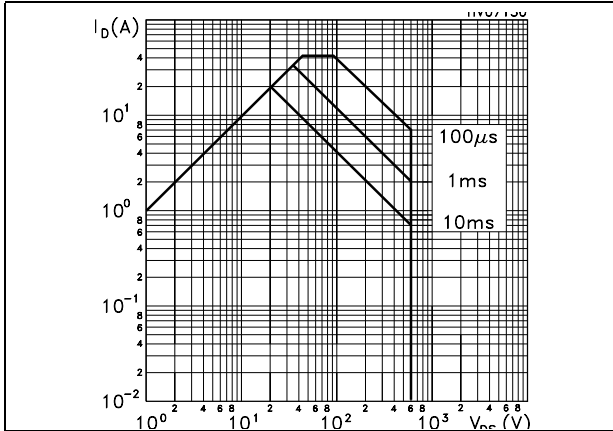


Figure 2. Thermal impedance TO-220 / D²PAK/I²PAK

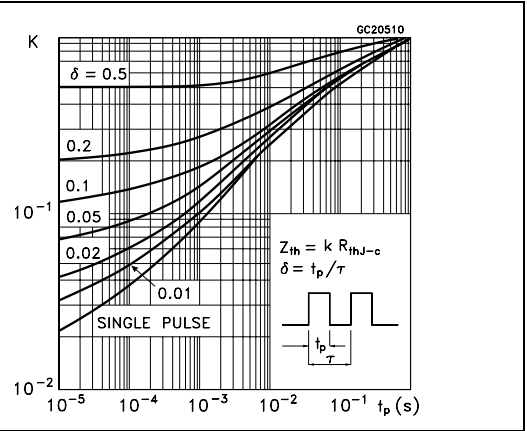


Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

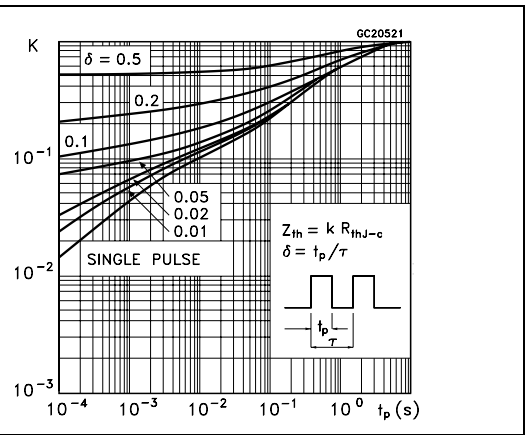
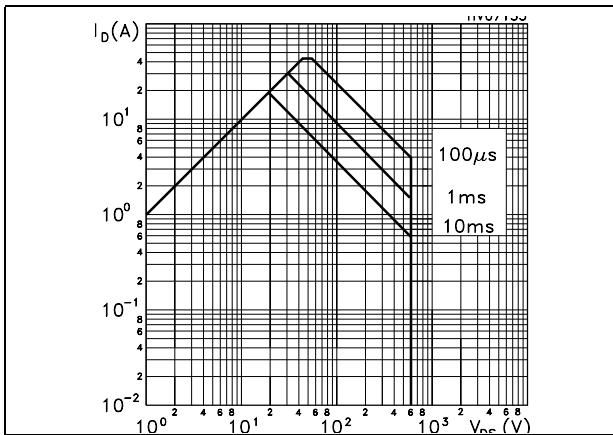


Figure 5. Output characteristics

Figure 6. Transfer characteristics

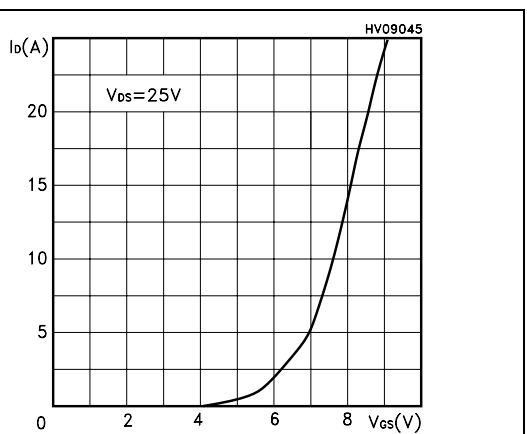
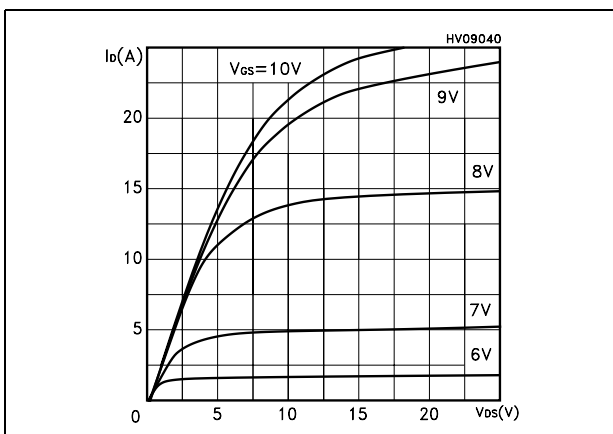


Figure 7. Transconductance

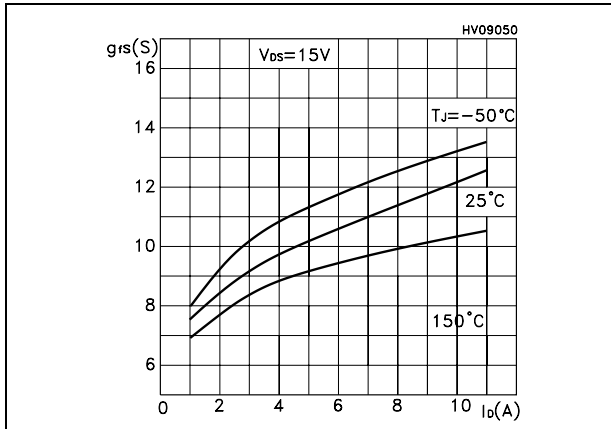


Figure 8. Static drain-source on resistance

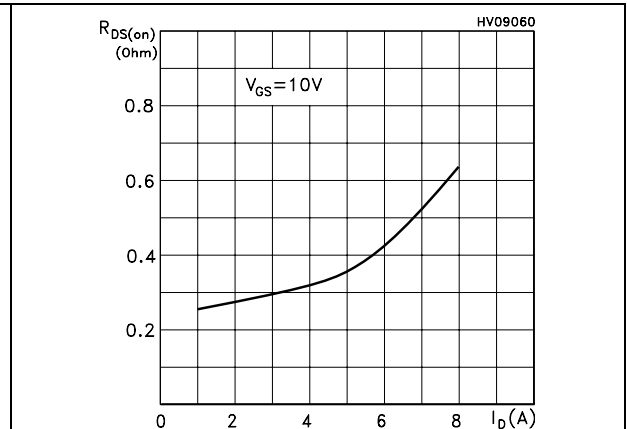


Figure 9. Gate charge vs gate-source voltage

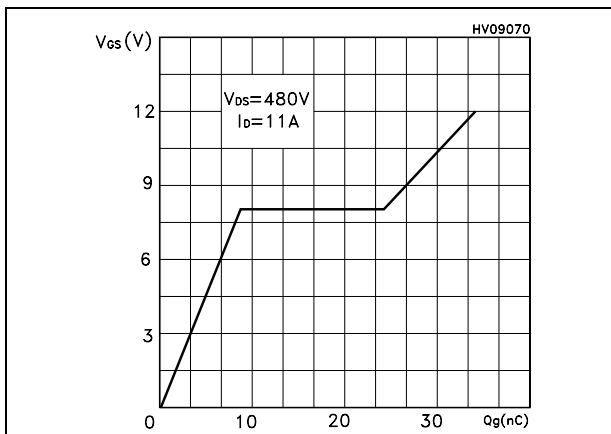


Figure 10. Capacitance variations

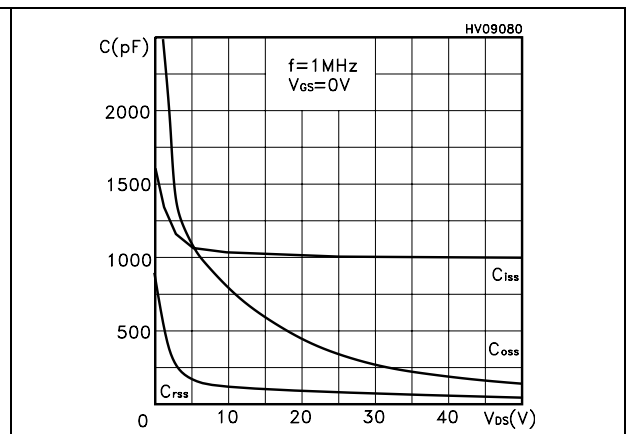


Figure 11. Normalized gate threshold voltage vs temperature

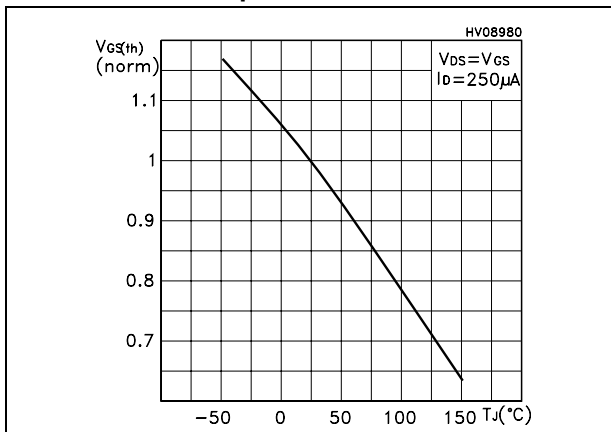


Figure 12. Normalized on resistance vs temperature

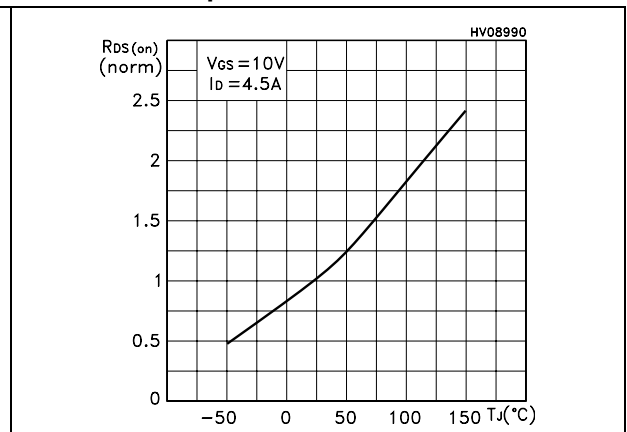
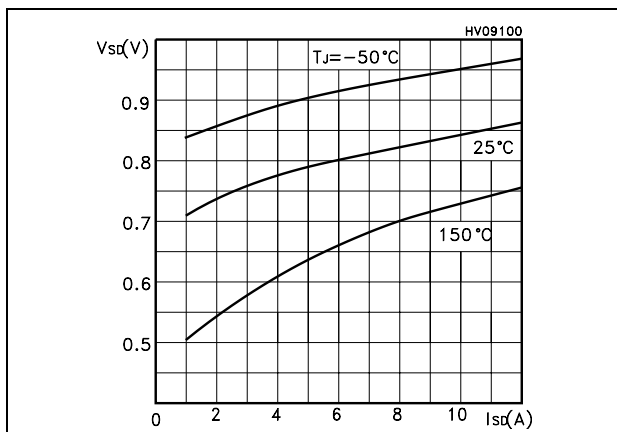


Figure 13. Source-drain diode forward characteristics



3 Test circuit

Figure 14. Switching times test circuit for resistive load

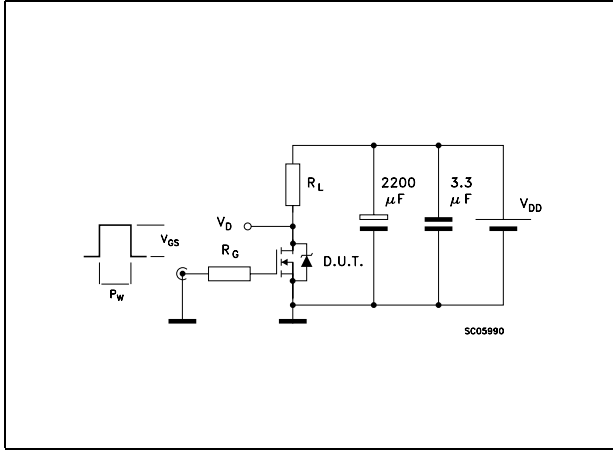


Figure 15. Gate charge test circuit

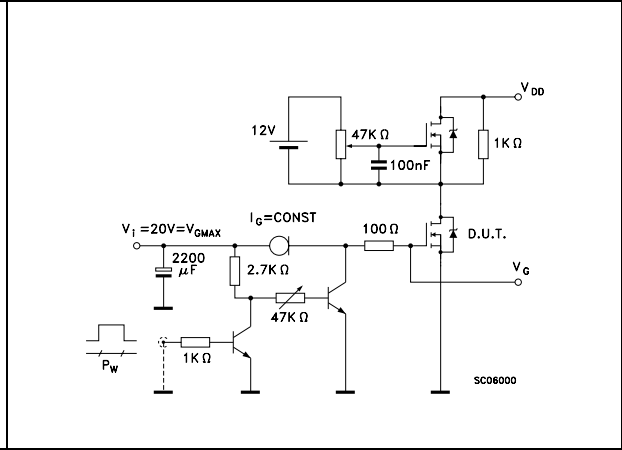


Figure 16. Test circuit for inductive load switching and diode recovery times



Figure 17. Unclamped Inductive load test circuit



Figure 18. Unclamped inductive waveform



Figure 19. Switching time waveform

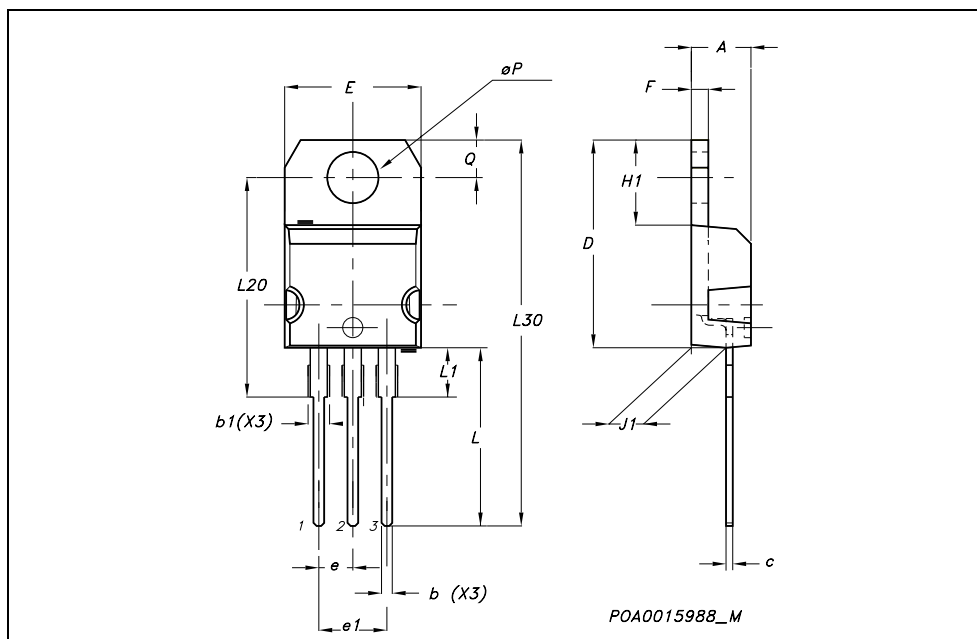


4 Package mechanical data

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

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 | 1.15 | | 1.70 | 0.045 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 15.75 | 0.60 | | 0.620 |
| 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 | | 0.052 |
| 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 | |
| øP | 3.75 | | 3.85 | 0.147 | | 0.151 |
| Q | 2.65 | | 2.95 | 0.104 | | 0.116 |



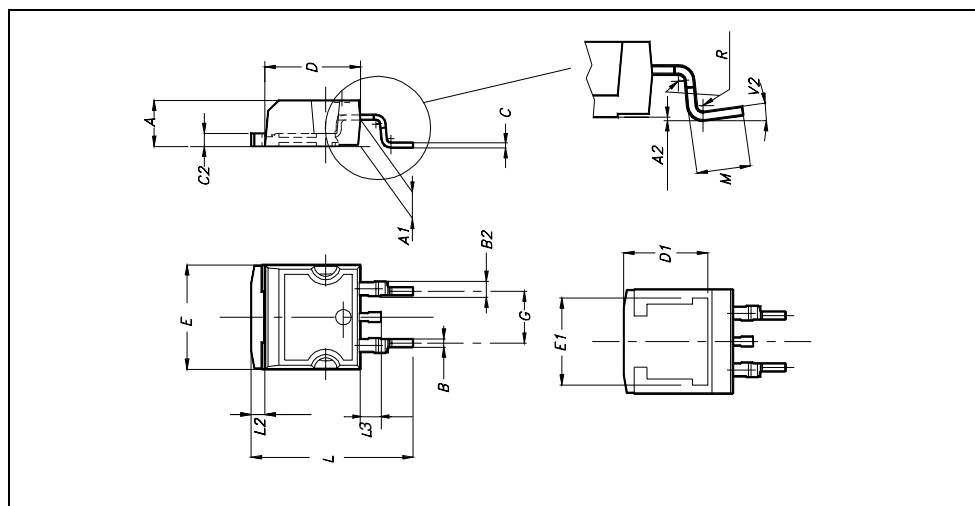
TO-220FP MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|-----|------|-------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 4.6 | 0.173 | | 0.181 |
| B | 2.5 | | 2.7 | 0.098 | | 0.106 |
| D | 2.5 | | 2.75 | 0.098 | | 0.108 |
| E | 0.45 | | 0.7 | 0.017 | | 0.027 |
| F | 0.75 | | 1 | 0.030 | | 0.039 |
| F1 | 1.15 | | 1.7 | 0.045 | | 0.067 |
| F2 | 1.15 | | 1.7 | 0.045 | | 0.067 |
| G | 4.95 | | 5.2 | 0.195 | | 0.204 |
| G1 | 2.4 | | 2.7 | 0.094 | | 0.106 |
| H | 10 | | 10.4 | 0.393 | | 0.409 |
| L2 | | 16 | | | 0.630 | |
| L3 | 28.6 | | 30.6 | 1.126 | | 1.204 |
| L4 | 9.8 | | 10.6 | .0385 | | 0.417 |
| L5 | 2.9 | | 3.6 | 0.114 | | 0.141 |
| L6 | 15.9 | | 16.4 | 0.626 | | 0.645 |
| L7 | 9 | | 9.3 | 0.354 | | 0.366 |
| Ø | 3 | | 3.2 | 0.118 | | 0.126 |



D²PAK 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

D²PAK 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 |

* on sales type

6 Revision history

Table 8. Revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 09-Sep-2004 | 1 | First Release |
| 10-Jun-2005 | 2 | Typing error, wrong description |
| 26-Jul-2006 | 3 | The document has been reformatted, no content change |
| 31-Aug-2006 | 4 | Typo mistake on order code |
| 21-Dec-2006 | 5 | Various changes on "Test conditions" for Table 5. and Table 6. |
| 12-Jan-2007 | 6 | Order code has been corrected |

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