



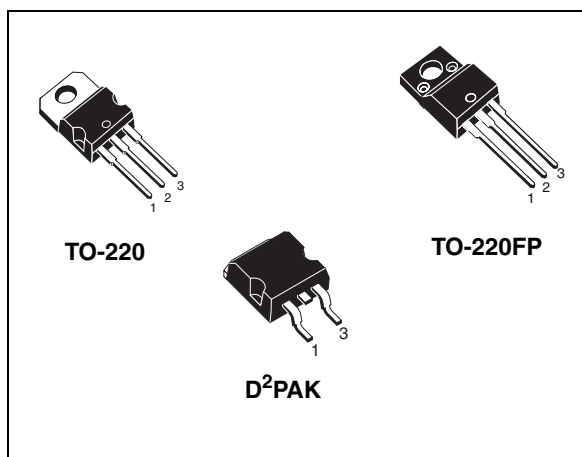
STB11NK40Z - STP11NK40ZFP STP11NK40Z

N-channel 400V - 0.49Ω - 9A TO-220 - TO-220FP - D²PAK
Zener-protected SuperMESH™ Power MOSFET

General features

| Type | V _{DSS} | R _{DS(on)} | I _D | P _w |
|--------------|------------------|---------------------|----------------|----------------|
| STB11NK40Z | 400V | <0.55Ω | 10A | 110W |
| STP11NK40Z | 400V | <0.55Ω | 10A | 110W |
| STP11NK40ZFP | 400V | <0.55Ω | 10A | 30W |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability



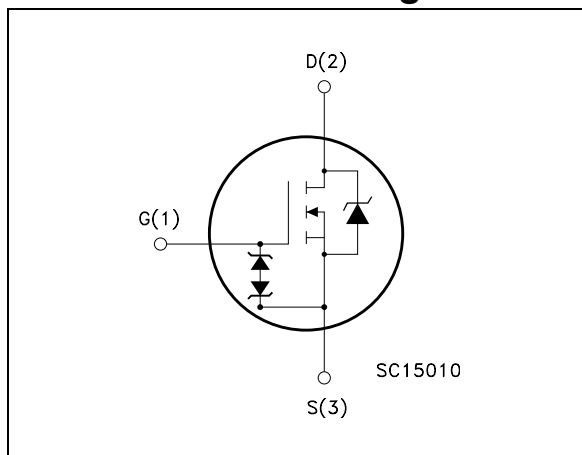
Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications.

Applications

- Switching application

Internal schematic diagram



Order codes

| Part number | Marking | Package | Packaging |
|--------------|------------|--------------------|-------------|
| STB11NK40ZT4 | B11NK40Z | D ² PAK | Tape & reel |
| STP11NK40Z | P11NK40Z | TO-220 | Tube |
| STP11NK40ZFP | P11NK40ZFP | TO-220FP | Tube |

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1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|------------------------------------|---|---------------------------|---------------------|------|
| | | TO-220/D ² PAK | TO-220FP | |
| V _{DS} | Drain-source voltage (V _{GS} = 0) | 400 | | V |
| V _{DGR} | Drain-gate voltage (R _{GS} = 20kΩ) | 400 | | V |
| V _{GS} | Gate-source voltage | ± 30 | | V |
| I _D | Drain current (continuous) at T _C = 25°C | 9 | 9 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C =100°C | 5.67 | 5.67 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 36 | 36 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25°C | 110 | 30 | W |
| | Derating Factor | 0.88 | 0.24 | W/°C |
| V _{ESD(G-S)} | Gate source ESD (HBM-C= 100pF, R= 1.5kΩ) | 3500 | | V |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 4.5 | | V/ns |
| V _{ISO} | Insulation withstand voltage (DC) | -- | 2500 | V |
| T _J T _{stg} | Operating junction temperature Storage temperature | -55 to 150 | | °C |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 9A, di/dt ≤ 200 A/μs, V_{DD} ≤ V_{(BR)DSS}, T_J ≤ T_{JMAX}.

Table 2. Thermal data

| Symbol | Parameter | Value | | Unit |
|-----------------------|--|---------------------------|----------|------|
| | | TO-220/D ² PAK | TO-220FP | |
| R _{thj-case} | Thermal resistance junction-case max | 1.14 | 4.2 | °C/W |
| R _{thj-a} | Thermal resistance junction-ambient max | 62.5 | | °C/W |
| T _l | 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) | 9 | A |
| E _{AS} | Single pulse avalanche energy (starting T _J =25°C, I _d =I _{ar} , V _{dd} =50V) | 190 | 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 | $I_D = 1mA, V_{GS} = 0$ | 400 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{Max rating},$ $V_{DS} = \text{Max rating} @ 125^{\circ}C$ | | | 1 50 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20V, V_{DS} = 0$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 100\mu A$ | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10V, I_D = 4.5A$ | | 0.49 | 0.55 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|---|--|------|------------------|------|----------------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 15V, I_D = 4.5A$ | | 5.8 | | S |
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$ | | 930 140 30 | | pF pF pF |
| $C_{oss \text{ eq}}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0V \text{ to } 320V$ | | 78 | | pF |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 320V, I_D = 9A$ $V_{GS} = 10V$ (see Figure 17) | | 32 6 18.5 | | nC nC nC |

1. Pulsed: pulse duration=300 μs , 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 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------------------|---|---|------|----------------|------|----------------|
| $t_{d(on)}$ t_r | Turn-on Delay Time Rise Time | $V_{DD}=200\text{ V}$, $I_D=4.5\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ (see Figure 19) | | 20 20 | | ns ns |
| $t_{d(off)}$ t_f | Turn-off Delay Time Fall Time | $V_{DD}=200\text{ V}$, $I_D=4.5\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ (see Figure 19) | | 40 18 | | ns ns |
| $t_{r(Voff)}$ t_f t_c | Off-voltage Rise Time Fall Time Cross-over Time | $V_{DD}=320\text{ V}$, $I_D=9\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ (see Figure 19) | | 15 17 30 | | ns ns ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------------------------|--|---|-----|------------------|-----|--------------------------|
| I_{SD} | Source-drain current | | | | 9 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 36 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=9\text{ A}$, $V_{GS}=0$ | | | 1.6 | V |
| t_{rr} Q_{rr} I_{RRM} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_{SD}=9\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=45\text{ V}$, $T_j=150^\circ\text{C}$ | | 225 1.6 14 | | ns μC A |

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration=300 μs , duty cycle 1.5%

Table 8. Gate-source zener diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|------------------|-------------------------------|--|------|------|------|------|
| $BV_{GSO}^{(1)}$ | Gate-source breakdown voltage | $I_{GS}=\pm 1\text{ mA}$ (open drain) | 30 | | | V |

1. The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220 D²PAK

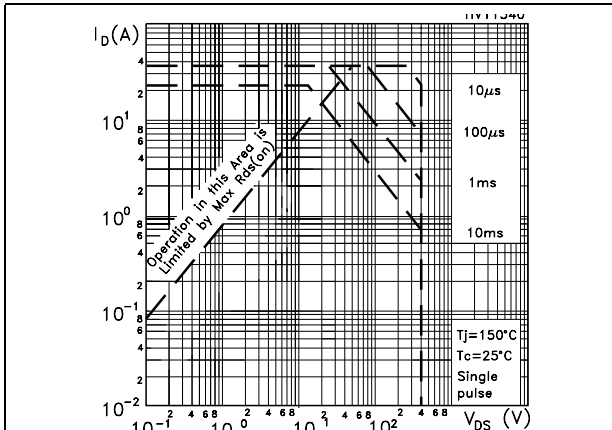


Figure 2. Thermal impedance for TO-220 D²PAK

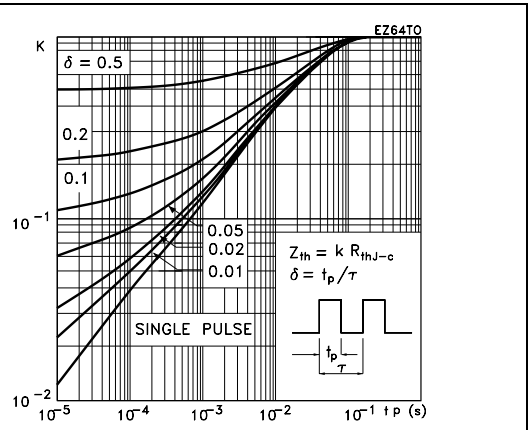


Figure 3. Safe operating area for TO-220FP

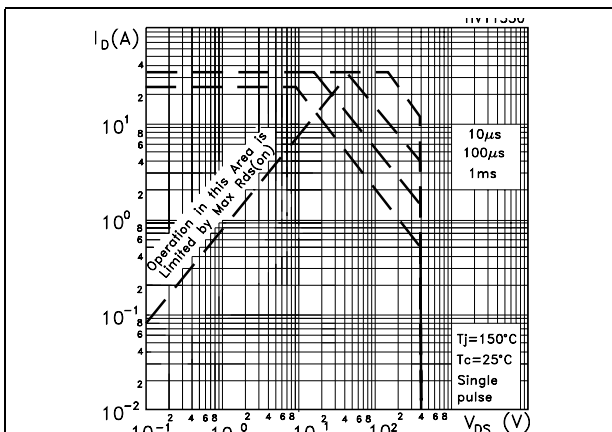


Figure 4. Thermal impedance for TO-220FP

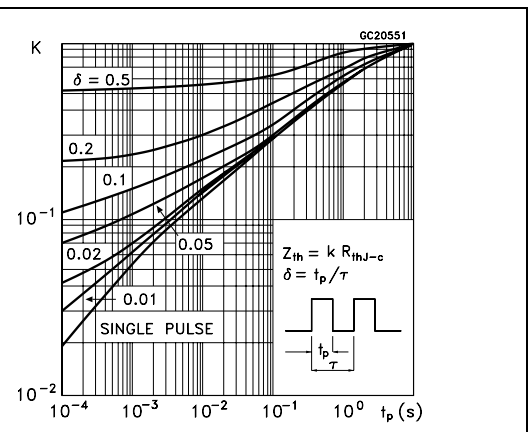


Figure 5. Output characteristics

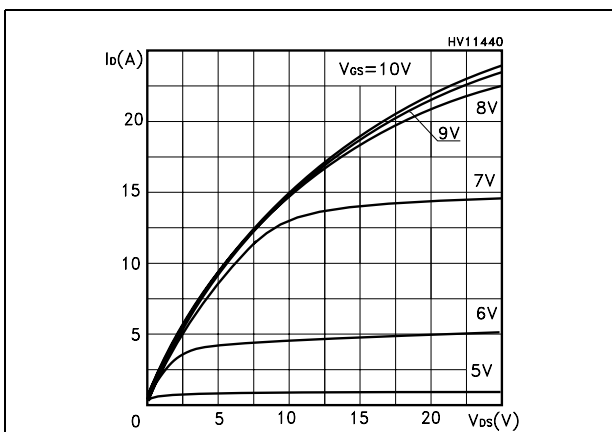


Figure 6. Transfer characteristics

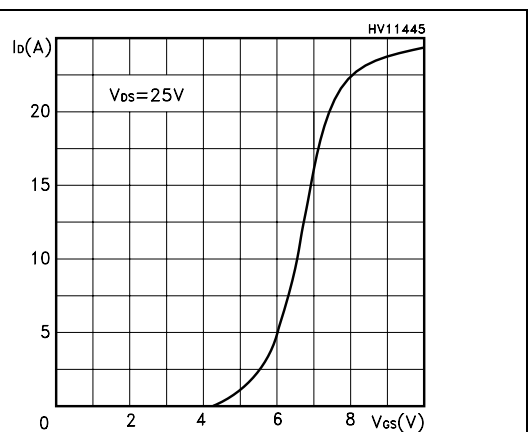


Figure 7. Transconductance

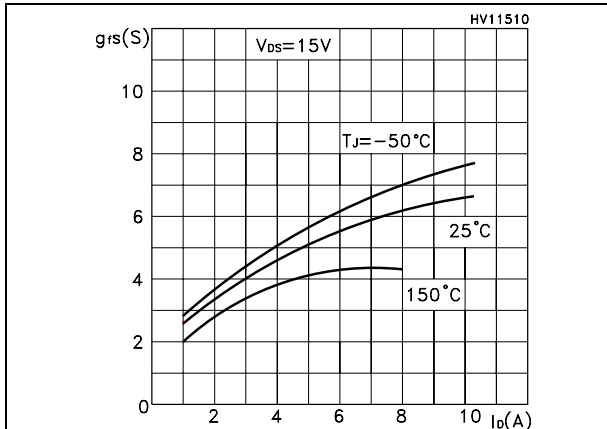


Figure 8. Static drain-source on resistance

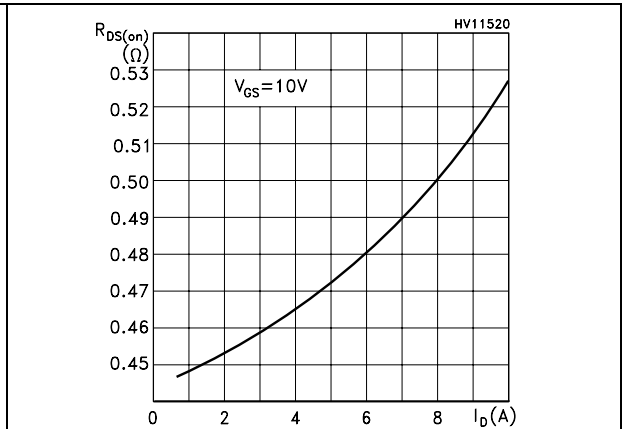


Figure 9. Gate charge vs gate-source voltage

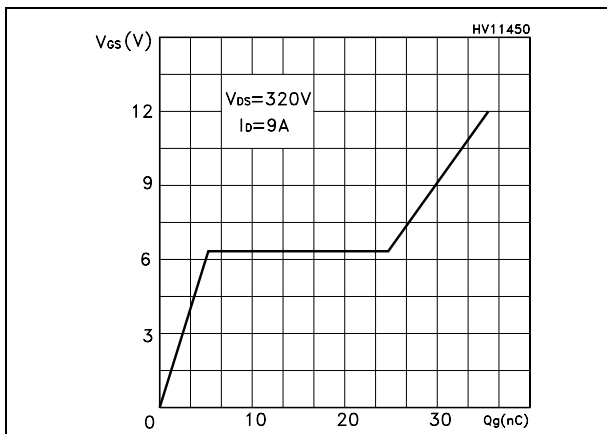


Figure 10. Capacitance variations

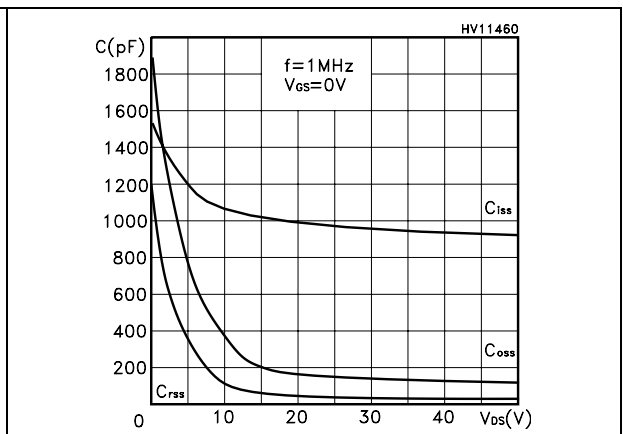


Figure 11. Normalized gate threshold voltage vs temperature

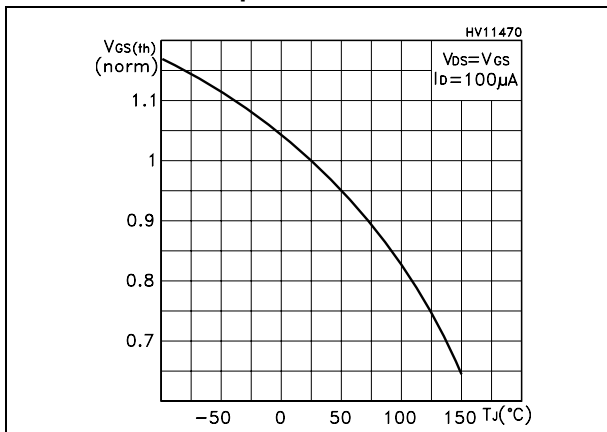


Figure 12. Normalized on resistance vs temperature

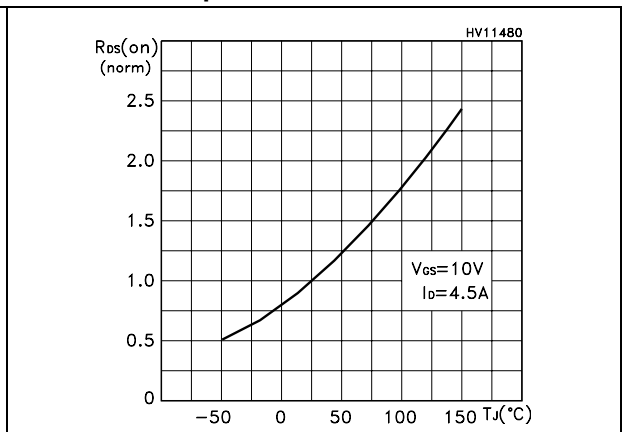


Figure 13. Source-drain diode forward characteristics

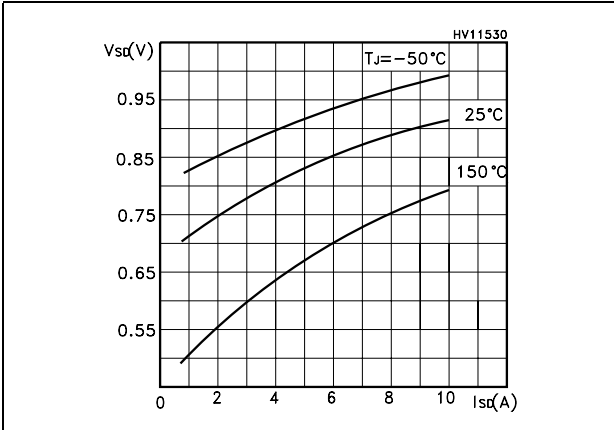


Figure 14. Normalized B_{VDSS} vs temperature

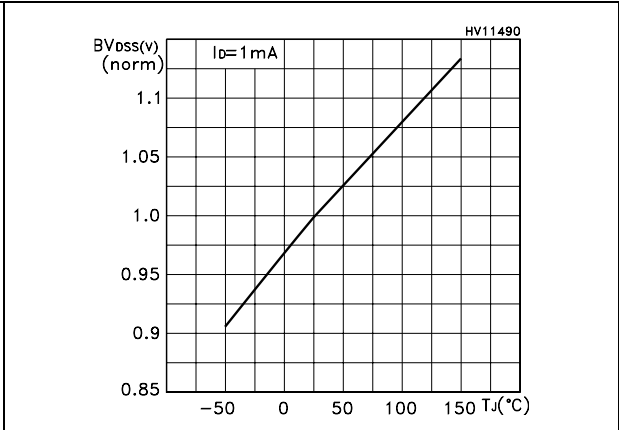
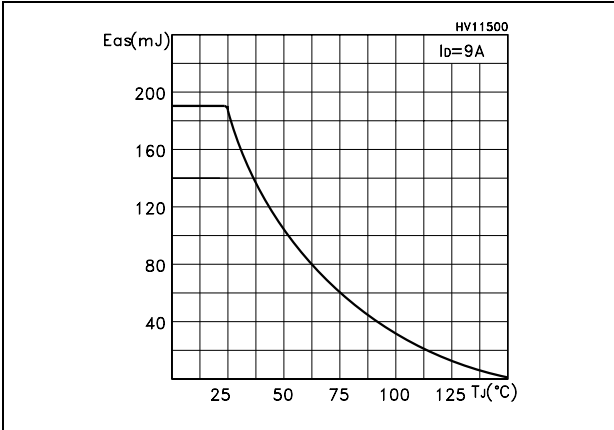


Figure 15. Maximum avalanche energy vs temperature



3 Test circuit

Figure 16. Switching times test circuit for resistive load

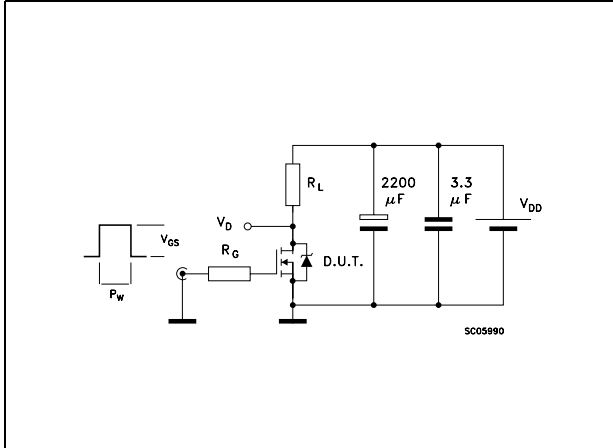


Figure 17. Gate charge test circuit



Figure 18. Test circuit for inductive load switching and diode recovery times



Figure 19. Unclamped Inductive load test circuit



Figure 20. Unclamped inductive waveform



Figure 21. 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

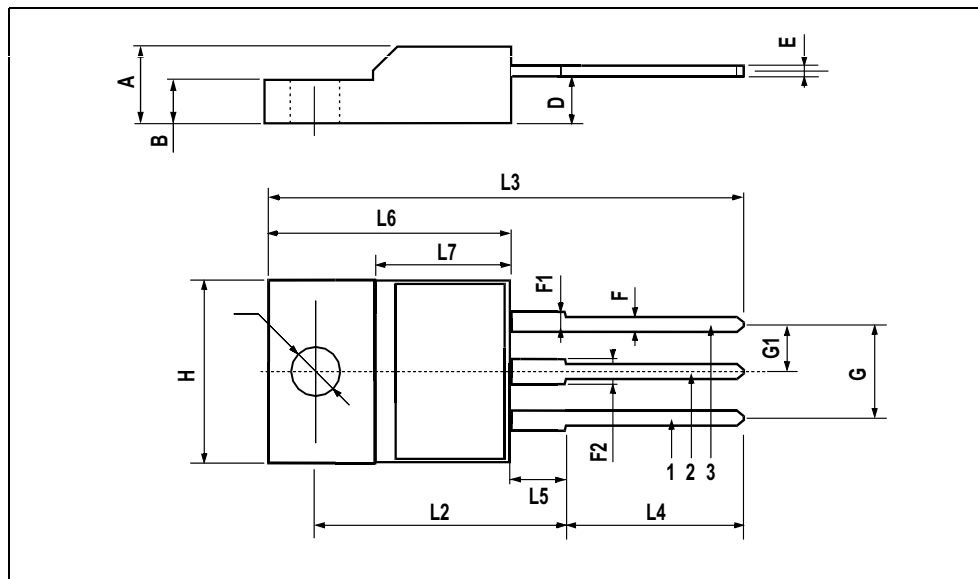
TO-220 MECHANICAL DATA

| 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 |



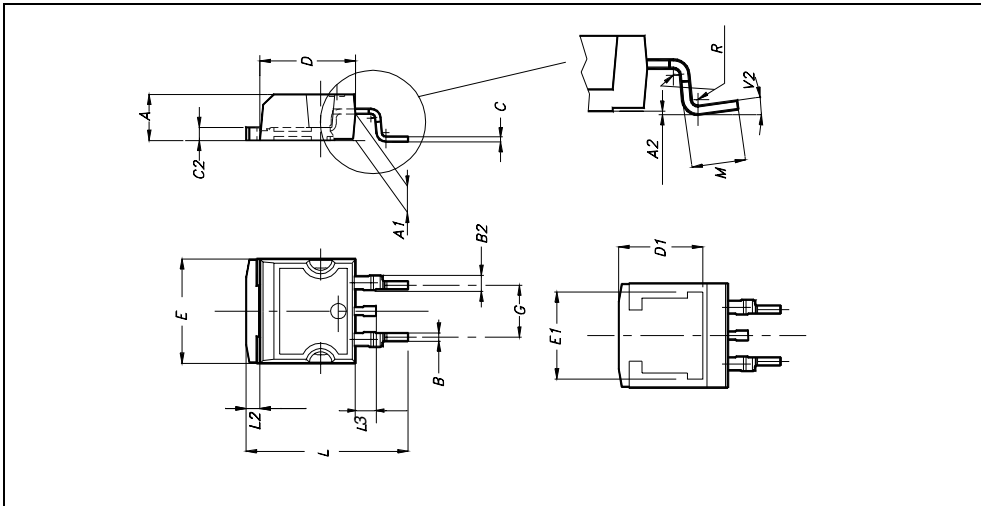
TO-220FP MECHANICAL DATA

| 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 |

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

TRL

Bending radius R min.

* on sales type

6 Revision history

Table 9. Revision history

| Date | Revision | Changes |
|-------------|-----------------|---|
| 23-Aug-2005 | 2 | Preliminary version |
| 28-Oct-2005 | 3 | Complete version |
| 26-Jul-2006 | 4 | New template, no content change |
| 22-Nov-2006 | 5 | Corrected unit on Table 4.: On/off states |
| 18-Jan-2007 | 6 | Typo mistakes on page 1 |

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