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STD9NM50N - STD9NM50N-1 STF9NM50N - STP9NM50N

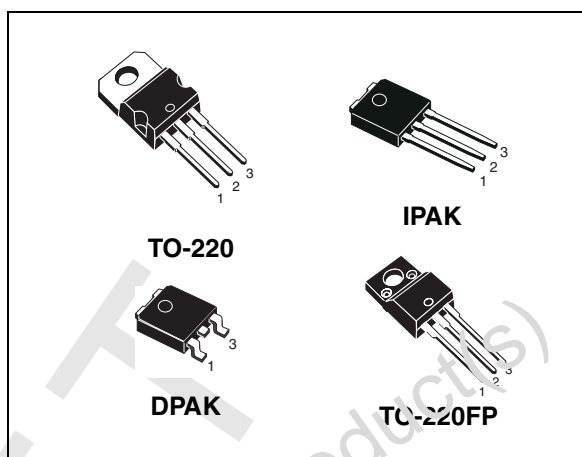
N-channel 500V - 0.47Ω - 7.5A - TO-220 - TO-220FP - IPAK - DPAK
Second generation MDmesh™ Power MOSFET

Features

| Type | V _{DSS} (@T _{Jmax}) | R _{DS(on)} | I _D |
|-------------|---|---------------------|---------------------|
| STD9NM50N | 550V | <0.56Ω | 7.5A |
| STD9NM50N-1 | 550V | <0.56Ω | 7.5A |
| STP9NM50N | 550V | <0.56Ω | 7.5A |
| STF9NM50N | 550V | <0.56Ω | 7.5A ⁽¹⁾ |

1. Limited only by maximum temperature allowed

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance



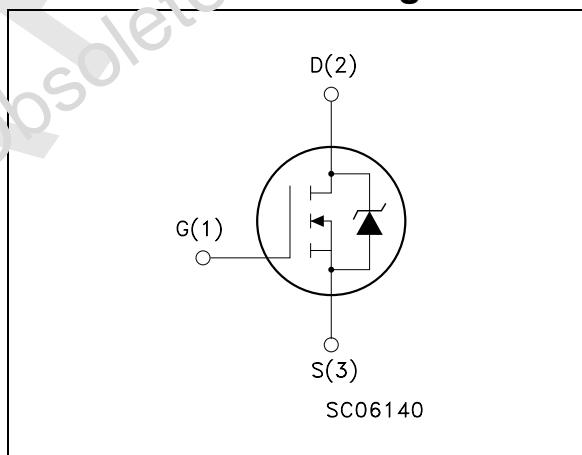
Description

This series of devices implements second generation MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the Company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Applications

- Switching application

Internal schematic diagram



Order codes

| Part number | Marking | Package | Packaging |
|-------------|---------|----------|-------------|
| STD9NM50N-1 | D9NM50N | IPAK | Tube |
| STD9NM50N | D9NM50N | DPAK | Tape & reel |
| STP9NM50N | P9NM50N | TO-220 | Tube |
| STF9NM50N | F9NM50N | TO-220FP | Tube |

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Obsolete Product(s) - Obsolete Product(s)
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1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------|---|---------------------|--------------------|------------------|
| | | TO-220 DPAK/IPAK | TO-220FP | |
| V_{DS} | Drain-source voltage ($V_{GS}=0$) | 500 | | V |
| V_{GS} | Gate-source voltage | ± 25 | | V |
| I_D | Drain current (continuous) at $T_C = 25^\circ\text{C}$ | 7.5 | 7.5 ⁽¹⁾ | A |
| I_D | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 5 | 5 ⁽¹⁾ | A |
| $I_{DM}^{(2)}$ | Drain current (pulsed) | 30 | 30 ⁽¹⁾ | A |
| P_{TOT} | Total dissipation at $T_C = 25^\circ\text{C}$ | 70 | 25 | W |
| $dv/dt^{(3)}$ | Peak diode recovery voltage slope | 15 | | V/ns |
| V_{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink ($t=1\text{s}; T_C=25^\circ\text{C}$) | -- | 2500 | V |
| T_j T_{stg} | Operating junction temperature Storage temperature | -55 to 150 | | $^\circ\text{C}$ |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 7.5\text{A}$, $di/dt \leq 400\text{A}/\mu\text{s}$, $V_{DD} = 80\% V_{(BR)DSS}$

Table 2. Thermal data

| Symbol | Parameter | TO-220 DPAK/IPAK | TO-220FP | Unit |
|----------------|--|---------------------|----------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 1.78 | 5 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-amb max | 62.5 | | $^\circ\text{C}/\text{W}$ |
| T_l | Maximum lead temperature for soldering purpose | 300 | | $^\circ\text{C}$ |

Table 3. Avalanche characteristics

| Symbol | Parameter | Max value | Unit |
|----------|--|-----------|------|
| I_{AS} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max) | 3 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_j=25^\circ\text{C}$, $I_D=I_{AS}$, $V_{DD}= 50\text{V}$) | 150 | 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 | $I_D = 1mA, V_{GS} = 0$ | 500 | | | V |
| $dv/dt^{(1)}$ | Drain-source voltage slope | $V_{DD} = 400V, I_D = 7.5A, V_{GS} = 10V$ | | 35 | | V/ns |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{Max rating}, V_{DS} = \text{Max rating}, T_c = 125^{\circ}C$ | | | 1 100 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20V$ | | | 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 250\mu A$ | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10V, I_D = 3.7A$ | | 0.47 | 0.56 | Ω |

1. Characteristics value at turn off on inductive load

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|-------------------------------------|---|---|-----|----------------|-----|----------------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 15V, I_D = 3.7A$ | | 5 | | S |
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 50V, f = 1MHz, V_{GS} = 0$ | | 570 46 6 | | pF pF pF |
| $C_{oss\ eq.}^{(2)}$ | Equivalent output characteristics | $V_{GS} = 0, V_{DS} = 0V \text{ to } 400V$ | | 94 | | pF |
| R_g | Gate input resistance | $f = 1MHz$ Gate DC Bias=0 Test signal level=20mV Open drain | | 6 | | Ω |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 400V, I_D = 7.5A$ $V_{GS} = 10V$ (see Figure 16) | | 20 4 10 | | 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 |
|--------------|---------------------|---|-----|-----|-----|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}=250V, I_D=3.7A,$ $R_G=4.7\Omega, V_{GS}=10V$ <i>(see Figure 15)</i> | | 11 | | ns |
| t_r | Rise time | | | 16 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 45 | | ns |
| t_f | Fall time | | | 19 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|-----------------|-------------------------------|--|-----|-----|-----|---------|
| I_{SD} | Source-drain current | | | | 7.5 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 30 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=7.5A, V_{GS}=0$ | | | 1.2 | V |
| t_{rr} | Reverse recovery time | $I_{SD}=7.5A, di/dt=100A/\mu s,$ $V_{DD}=100V, T_j=150^\circ C$ <i>(see Figure 17)</i> | | 420 | | ns |
| Q_{rr} | Reverse recovery charge | | | 3 | | μC |
| I_{RRM} | Reverse recovery current | | | 14 | | A |
| t_{rr} | Reverse recovery time | $I_{SD}=7.5A, di/dt=100A/\mu s,$ $V_{DD}=100V, T_j= 25^\circ C$ <i>(see Figure 17)</i> | | 280 | | ns |
| Q_{rr} | Reverse recovery charge | | | 2 | | μC |
| I_{RRM} | Reverse recovery current | | | 14 | | 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 / DPAK / IPAK

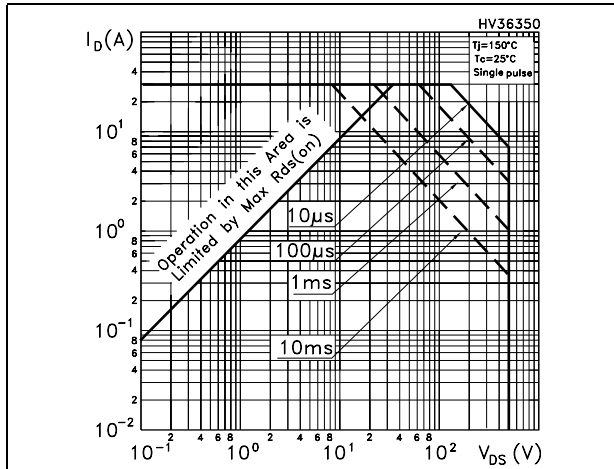


Figure 2. Thermal impedance for TO-220 / DPAK / IPAK

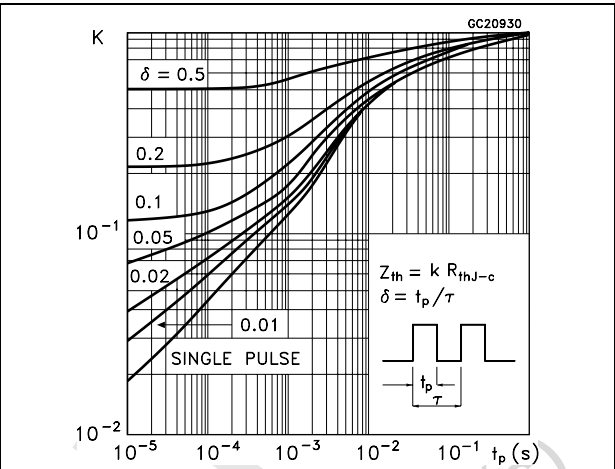


Figure 3. Safe operating area for TO-220FP

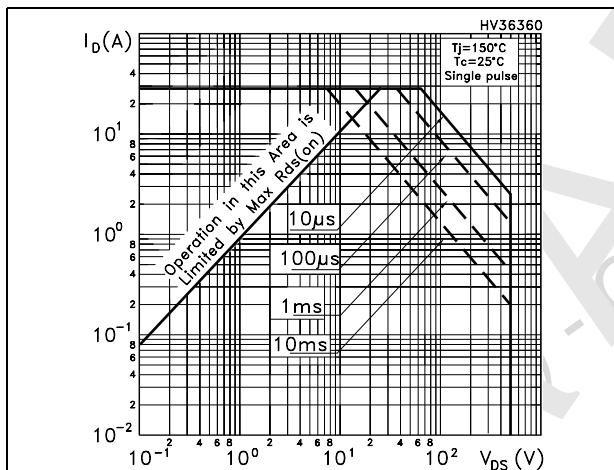


Figure 4. Thermal impedance for TO-220FP

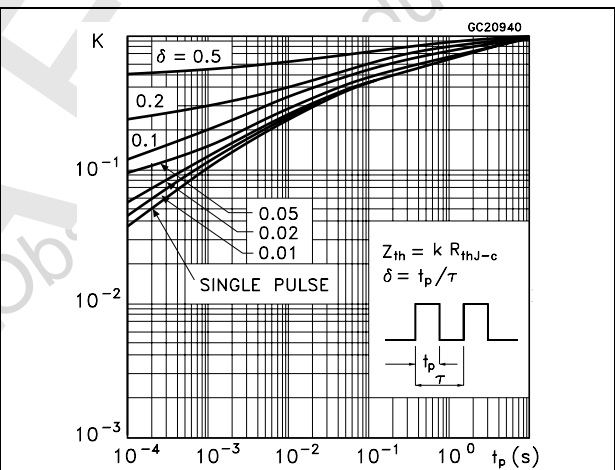


Figure 5. Output characteristics

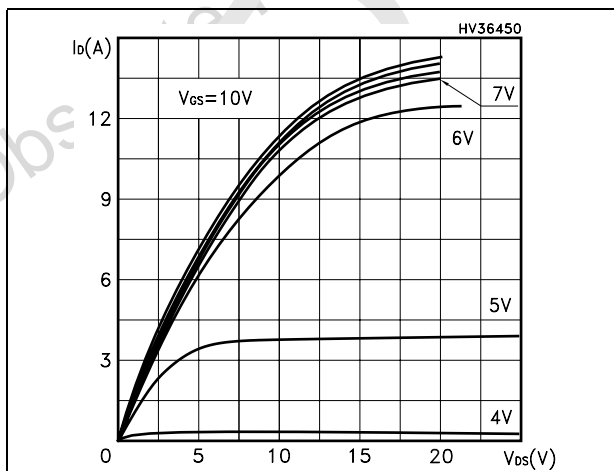


Figure 6. Transfer characteristics

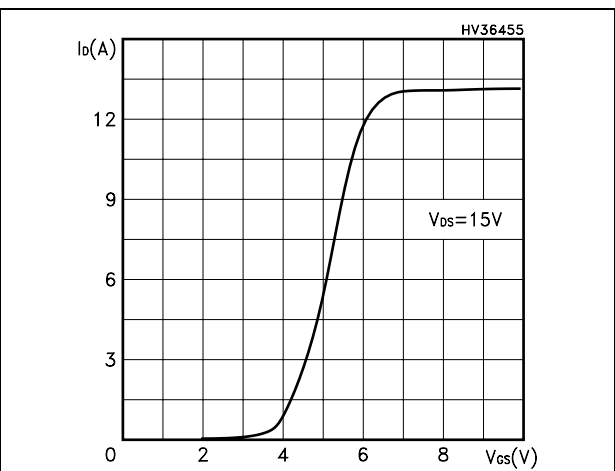


Figure 7. Transconductance

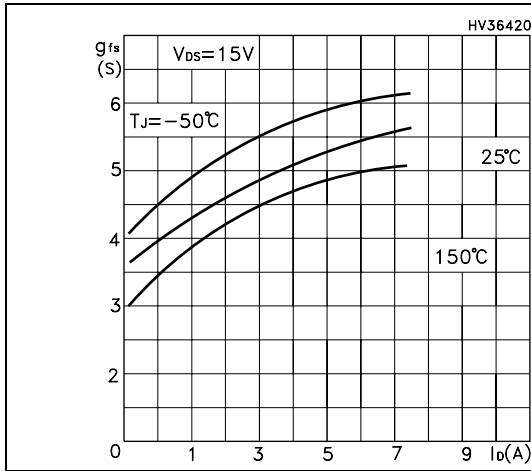


Figure 8. Static drain-source on resistance

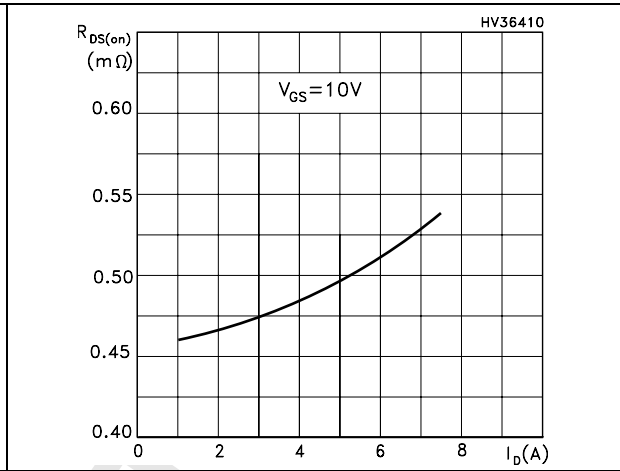


Figure 9. Gate charge vs. gate-source voltage

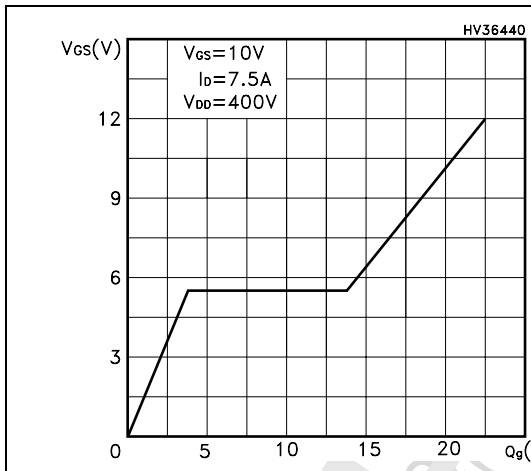


Figure 10. Capacitance variations

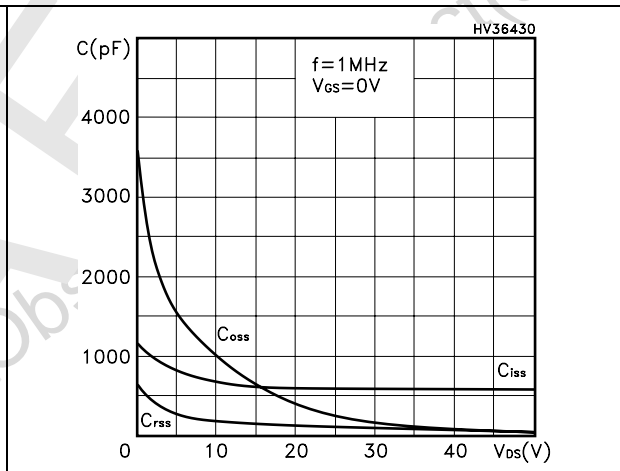


Figure 11. Normalized gate threshold voltage vs. temperature

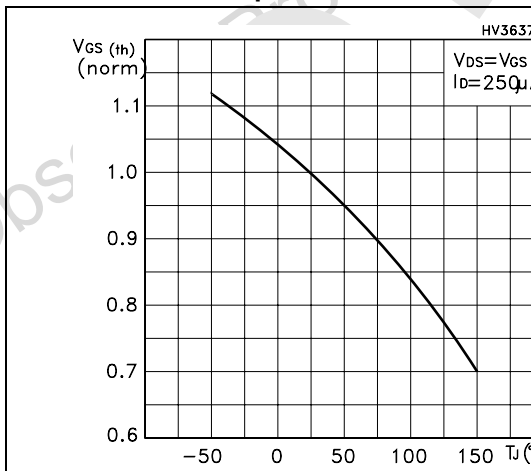


Figure 12. Normalized on resistance vs. temperature

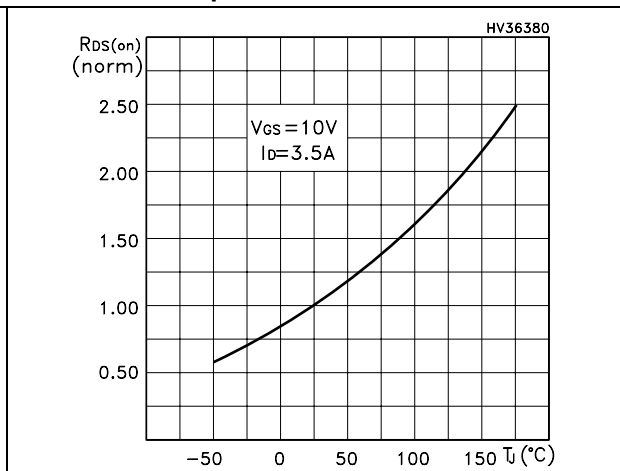


Figure 13. Source-drain diode forward characteristics

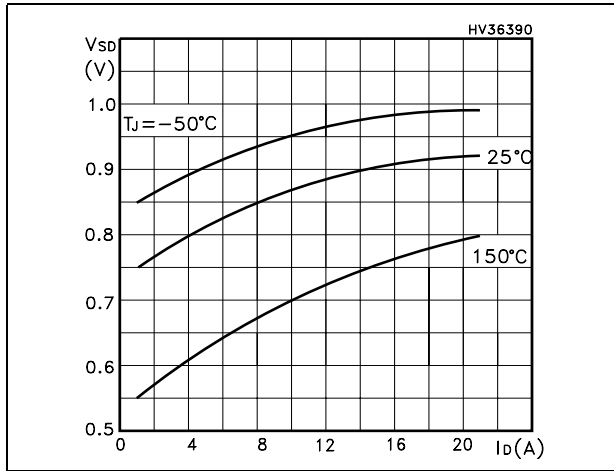
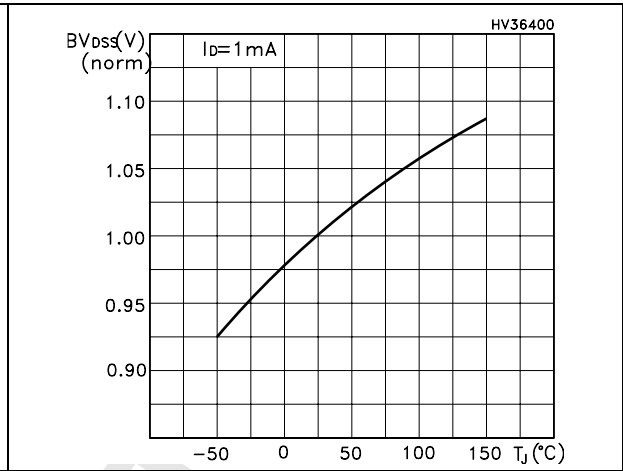


Figure 14. Normalized BV_{DSS} vs. temperature



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3 Test circuit

Figure 15. Switching times test circuit for resistive load

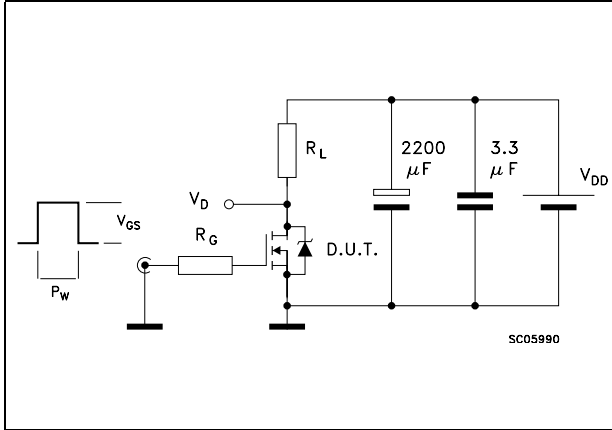


Figure 16. Gate charge test circuit

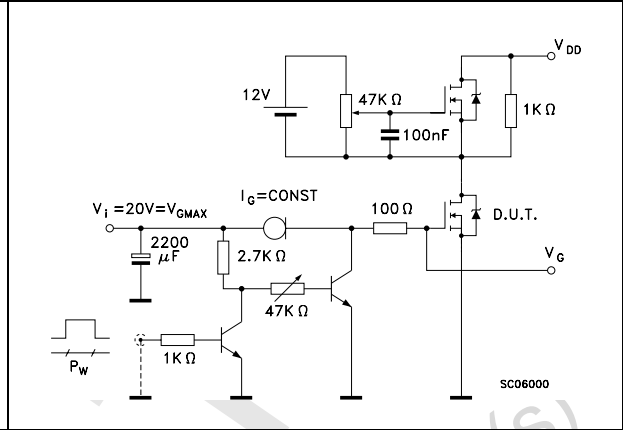


Figure 17. Test circuit for inductive load switching and diode recovery times

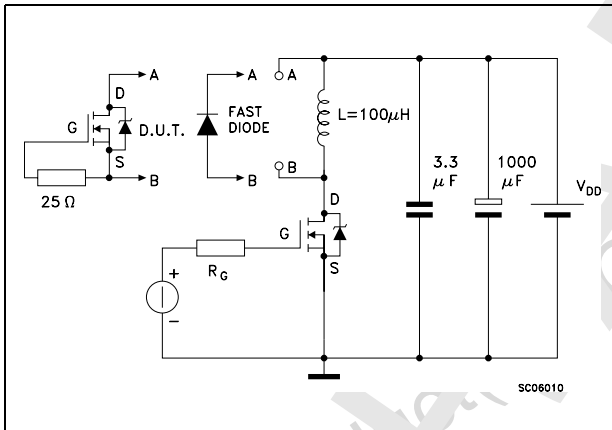


Figure 18. Unclamped inductive load test circuit

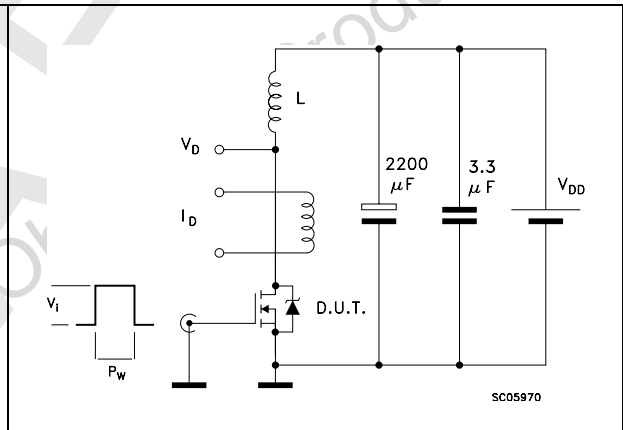


Figure 19. Unclamped inductive waveform

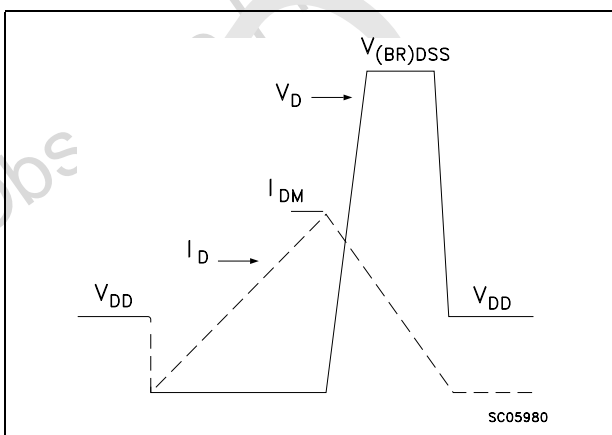
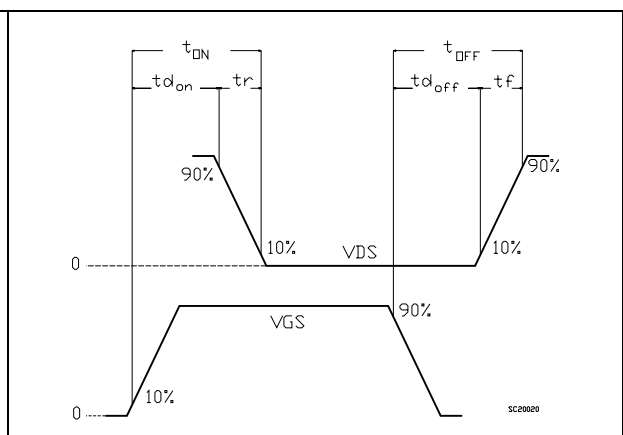


Figure 20. Switching time waveform



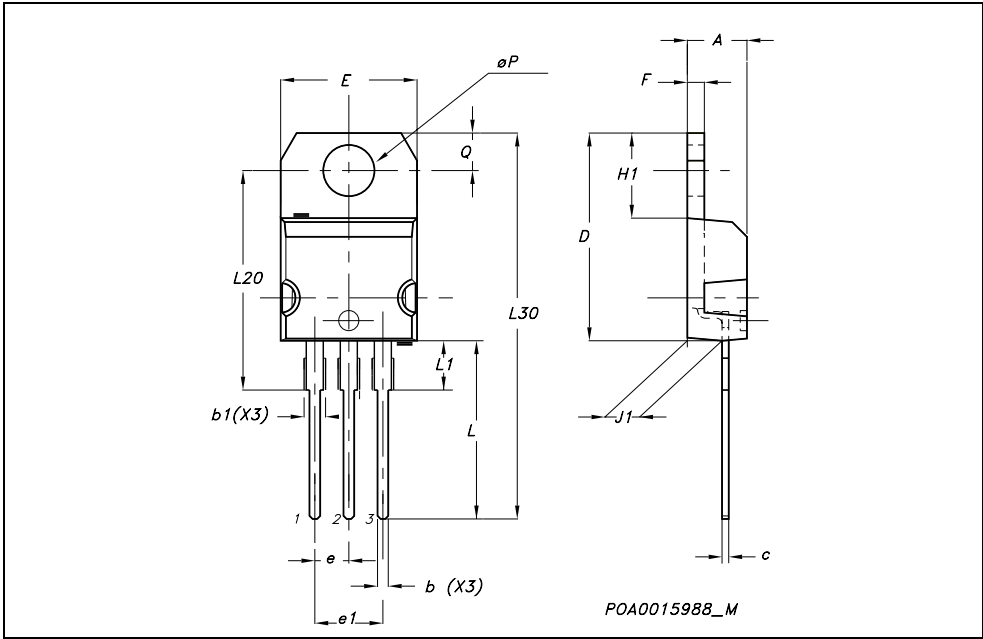
4 Package mechanical data

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

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TO-220 MECHANICAL DATA

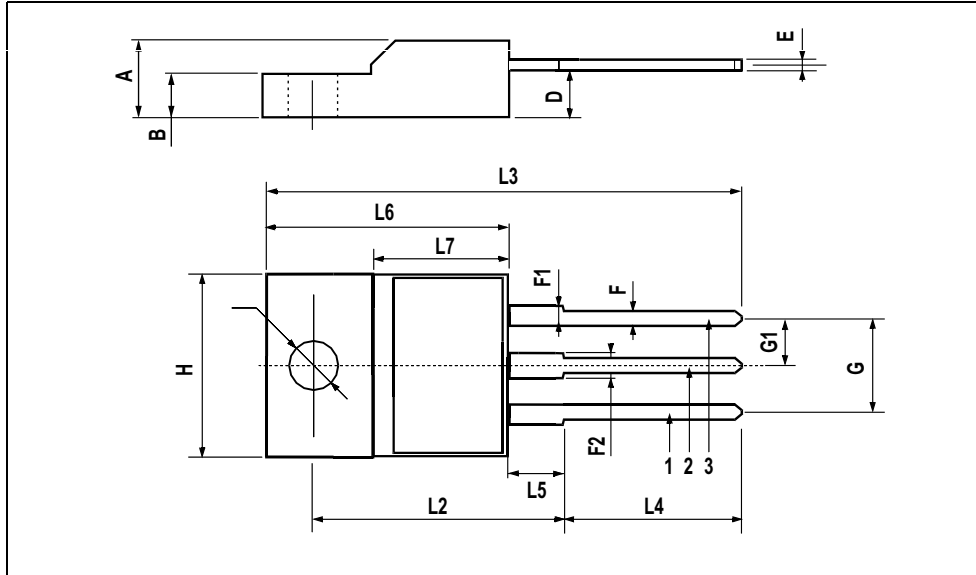
| DIM. | mm. | | | inch | | |
|------|-------|-------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.15 | | 1.70 | 0.045 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 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 |



Obsole

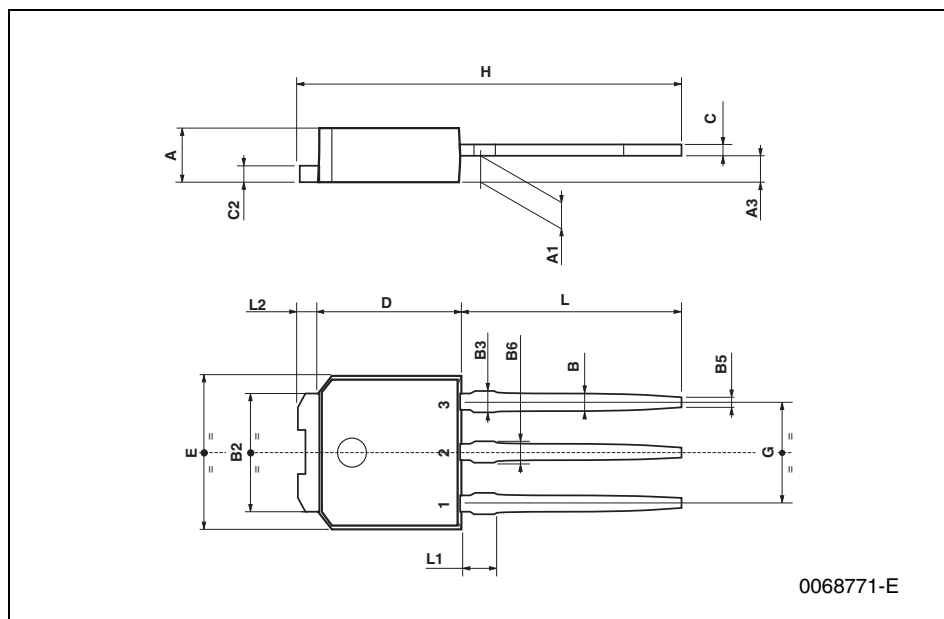
TO-220FP MECHANICAL DATA

| 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 |



TO-251 (IPAK) MECHANICAL DATA

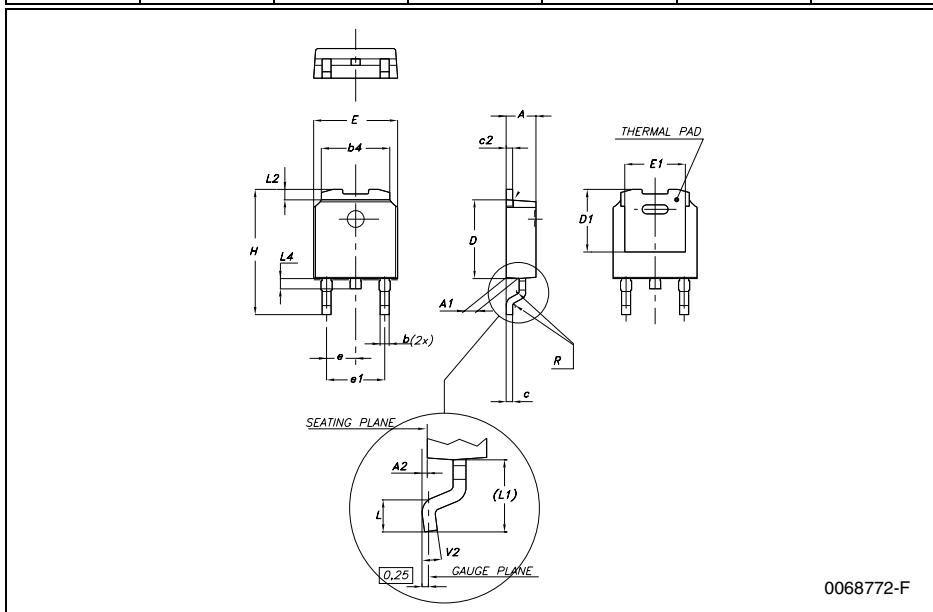
| DIM. | mm | | | inch | | |
|------|------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A3 | 0.7 | | 1.3 | 0.027 | | 0.051 |
| B | 0.64 | | 0.9 | 0.025 | | 0.031 |
| B2 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| B3 | | | 0.85 | | | 0.033 |
| B5 | | 0.3 | | | 0.012 | |
| B6 | | | 0.95 | | | 0.037 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.6 | 0.019 | | 0.023 |
| D | 6 | | 6.2 | 0.236 | | 0.244 |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| G | 4.4 | | 4.6 | 0.173 | | 0.181 |
| H | 15.9 | | 16.3 | 0.626 | | 0.641 |
| L | 9 | | 9.4 | 0.354 | | 0.370 |
| L1 | 0.8 | | 1.2 | 0.031 | | 0.047 |
| L2 | | 0.8 | 1 | | 0.031 | 0.039 |



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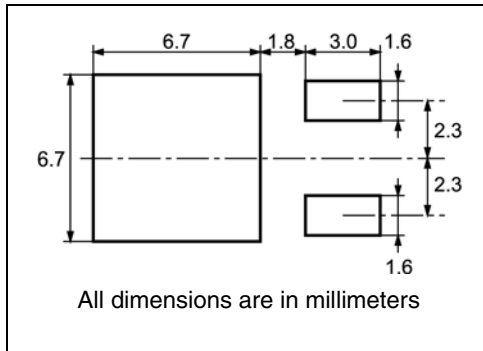
DPAK MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.64 | | 0.9 | 0.025 | | 0.035 |
| b4 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.6 | 0.019 | | 0.023 |
| D | 6 | | 6.2 | 0.236 | | 0.244 |
| D1 | | 5.1 | | | 0.200 | |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| E1 | | 4.7 | | | 0.185 | |
| e | | 2.28 | | | 0.090 | |
| e1 | 4.4 | | 4.6 | 0.173 | | 0.181 |
| H | 9.35 | | 10.1 | 0.368 | | 0.397 |
| L | 1 | | | 0.039 | | |
| (L1) | | 2.8 | | | 0.110 | |
| L2 | | 0.8 | | | 0.031 | |
| L4 | 0.6 | | 1 | 0.023 | | 0.039 |
| R | | 0.2 | | | 0.008 | |
| V2 | 0° | | 8° | 0° | | 8° |



5 Packaging mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT

| 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 |

| 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 |

6 Revision history

Table 8. Revision history

| Date | Revision | Changes |
|-------------|----------|---------------|
| 10-Apr-2007 | 1 | First release |

Obsolete Product(s) - Obsolete Product(s)

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