



THE DATASHEET OF STB21NM50N-1





STP/F21NM50N - STW21NM50N STB21NM50N - STB21NM50N-1

N-channel 500V - 0.15Ω - 18A TO-220/FP/D²/I²PAK/TO-247
Second generation MDmesh™ Power MOSFET

General features

| Type | V _{DSS} (@T _{jmax}) | R _{DS(on)} | I _D |
|--------------|---|---------------------|--------------------|
| STB21NM50N | 550V | < 0.19Ω | 18A |
| STB21NM50N-1 | 550V | < 0.19Ω | 18A |
| STF21NM50N | 550V | < 0.19Ω | 18A ⁽¹⁾ |
| STP21NM50N | 550V | < 0.19Ω | 18A |
| STW21NM50N | 550V | < 0.19Ω | 18A |

1. Limited by wire bonding

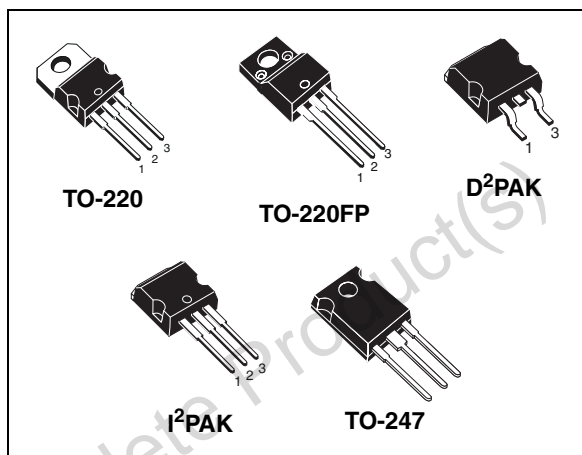
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

Description

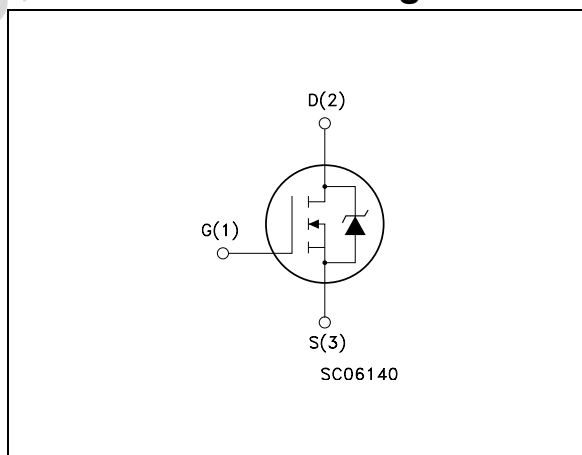
The devices are realized with the second generation of MDmesh Technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters

Applications

- Switching application



Internal schematic diagram



Order codes

| Part number | Marking | Package | Packaging |
|--------------|----------|--------------------|-------------|
| STB21NM50N | B21NM50N | D ² PAK | Tape & reel |
| STB21NM50N-1 | B21NM50N | I ² PAK | Tube |
| STF21NM50N | F21NM50N | TO-220FP | Tube |
| STP21NM50N | P21NM50N | TO-220 | Tube |
| STW21NM50N | W21NM50N | TO-247 | Tube |

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Obsolete Product(s) - Obsolete Product(s)

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|---|--|-------------------|------|
| | | TO-220/ D ² PAK/ I ² PAK/TO-247 | 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°C | 18 | 18 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100°C | 11 | 11 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 72 | 72 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25°C | 140 | 30 | W |
| | Derating factor | 1.12 | 0.23 | W/°C |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 15 | | V/ns |
| Viso | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s;T _C =25°C) | -- | 2500 | V |
| T _{stg} | Storage temperature | -55 to 150 | | °C |
| T _j | Max. operating junction temperature | 150 | | |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 18 A, di/dt ≤ 400 A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 2. Thermal data

| Symbol | Parameter | TO-220/D ² PAK/ I ² PAK / TO-247 | TO-220FP | Unit |
|-----------------------|--|---|----------|------|
| R _{thj-case} | Thermal resistance junction-case max | 0.89 | 4.21 | °C/W |
| R _{thj-amb} | 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 | Max value | Unit |
|-----------------|--|-----------|------|
| I _{AS} | 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) | 480 | mJ |

2 Electrical characteristics

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

Table 4. On/off states

| Symbol | Parameter | Test conditions | Value | | | Unit |
|---------------|--|--|-------|-------|---------|--------------------|
| | | | Min. | Typ. | Max. | |
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1mA, V_{GS} = 0$ | 500 | | | V |
| $dv/dt^{(1)}$ | Drain source voltage slope | $V_{DD}=400V, I_D=25A, V_{GS}=10V$ | 44 | | | 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 10 | 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 | $V_{GS} = 10V, I_D = 9A$ | | 0.150 | 0.190 | Ω |

1. Characteristic value at turn off on inductive load

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------|-------------------------------|---|------|------|------|----------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 15V, I_D = 9A$ | | 12 | | S |
| C_{iss} | Input capacitance | $V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$ | | 1950 | | pF |
| C_{oss} | Output capacitance | | | 420 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 60 | | pF |
| $C_{oss \text{ eq.}}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 400V$ | | 270 | | pF |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 250V, I_D = 9A$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 15.) | | 22 | | ns |
| t_r | Rise time | | | 18 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 90 | | ns |
| t_f | Fall time | | | 30 | | ns |
| Q_g | Total gate charge | $V_{DD} = 400V, I_D = 18A,$ $V_{GS} = 10V,$ (see Figure 16.) | | 65 | | nC |
| Q_{gs} | Gate-source charge | | | 10 | | nC |
| Q_{gd} | Gate-drain charge | | | 30 | | nC |
| R_g | Gate input resistance | $f=1\text{MHz}$ Gate DC Bias=0 test signal level=20mV open drain | | 1.6 | | Ω |

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. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------|
| I_{SD} | Source-drain current | | | | 18 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 72 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 18A, V_{GS} = 0$ | | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 18A,$ $di/dt=100A/\mu s$ $V_{DD} = 100V,$ (see Figure 17.) | | 360 | | ns |
| Q_{rr} | Reverse recovery charge | | | 5 | | μC |
| I_{RRM} | Reverse recovery current | | | 27 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 18A,$ $di/dt=100A/\mu s$ $V_{DD} = 100V, T_j = 150^\circ C$ (see Figure 17.) | | 464 | | ns |
| Q_{rr} | Reverse recovery charge | | | 6.5 | | μC |
| I_{RRM} | Reverse recovery current | | | 27 | | 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

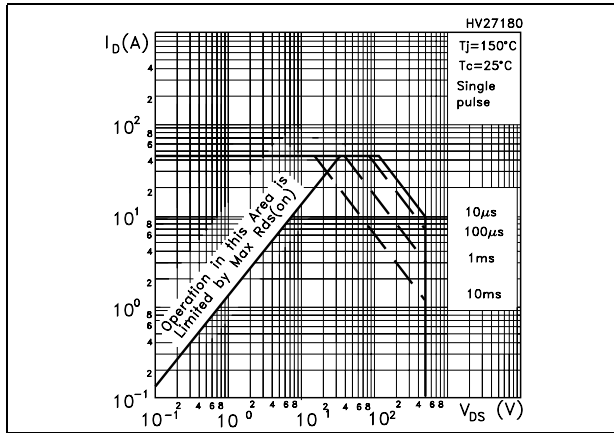


Figure 2. Thermal impedance

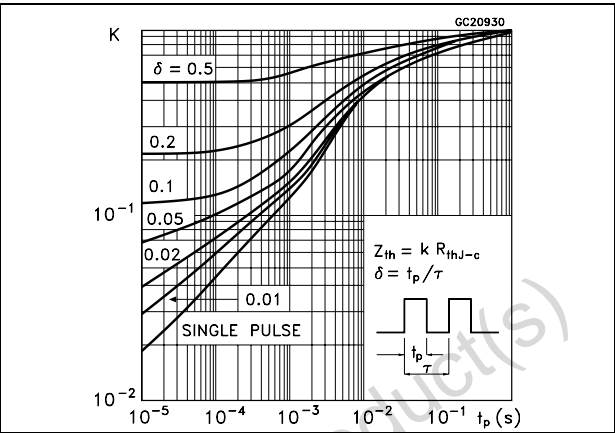


Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

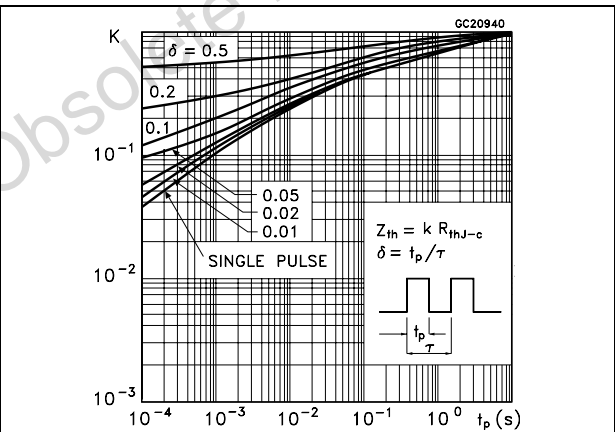
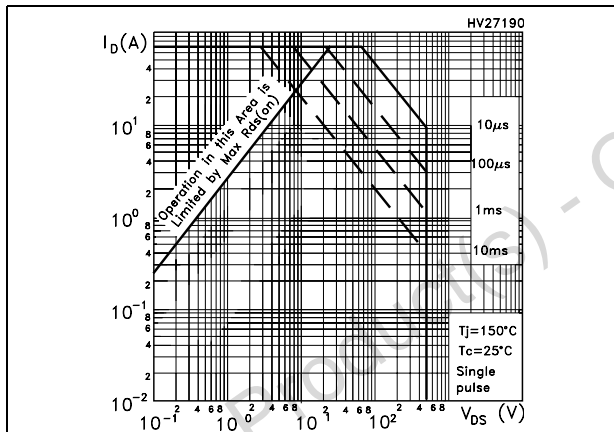


Figure 5. Output characteristics

Figure 6. Transfer characteristics

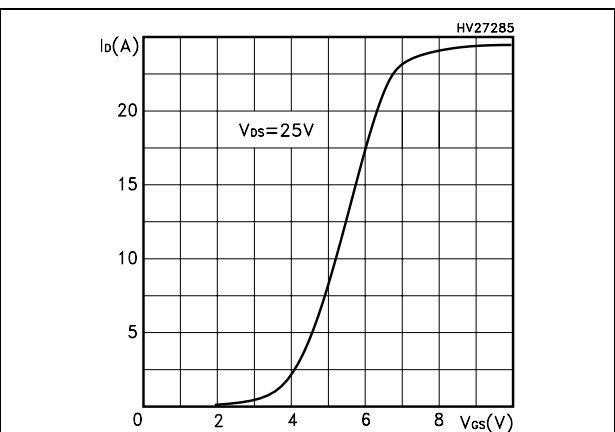
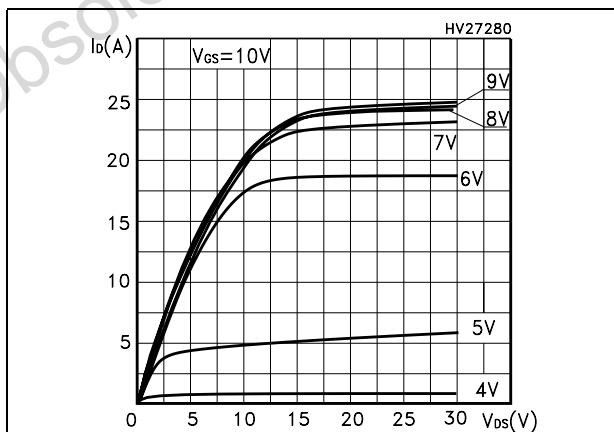


Figure 7. Transconductance

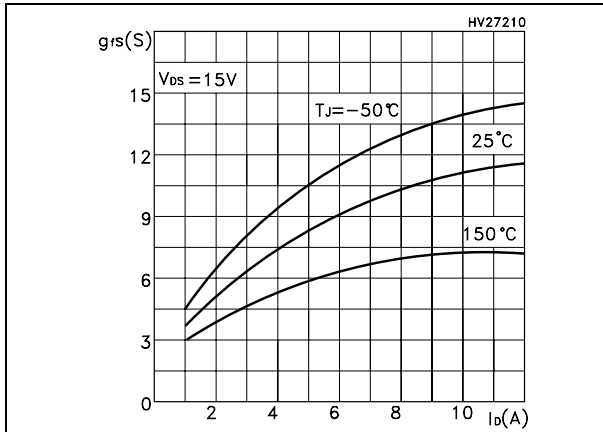


Figure 8. Static drain-source on resistance

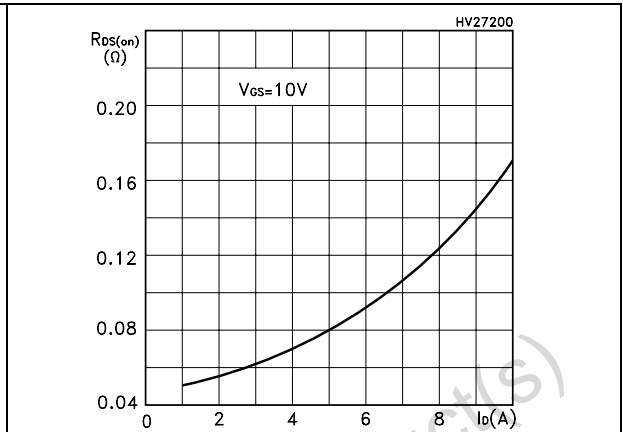


Figure 9. Gate charge vs gate-source voltage

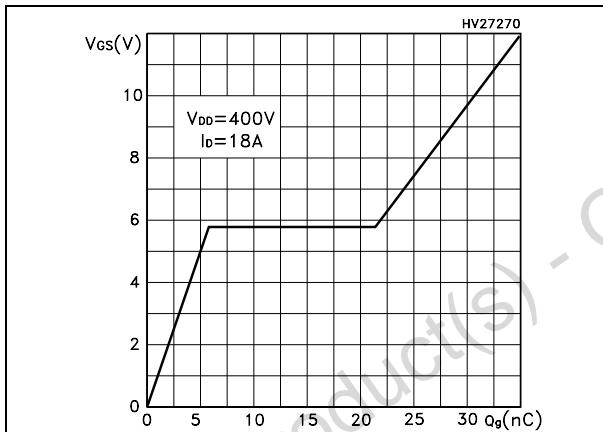


Figure 10. Capacitance variations

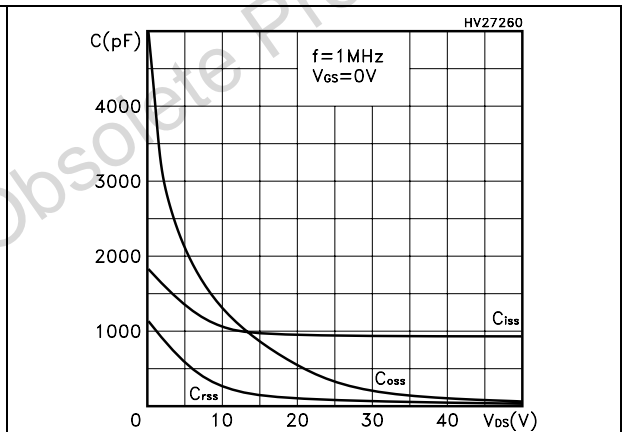


Figure 11. Normalized gate threshold voltage vs temperature

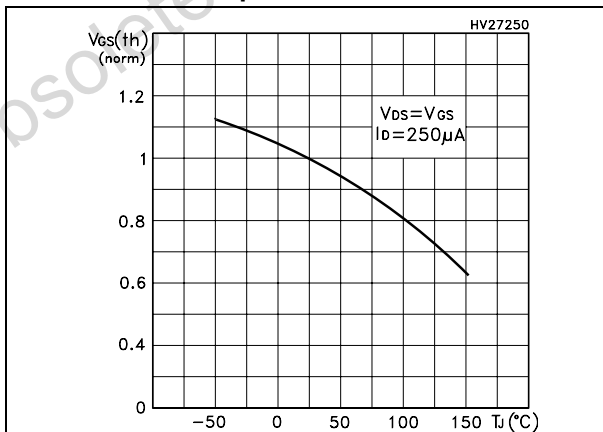


Figure 12. Normalized on resistance vs temperature

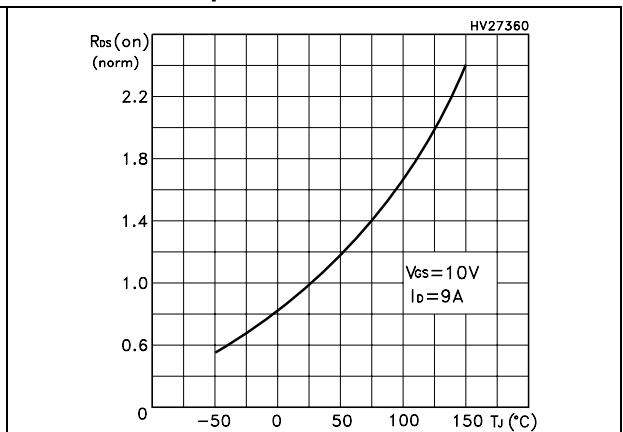


Figure 13. Source-drain diode forward characteristics

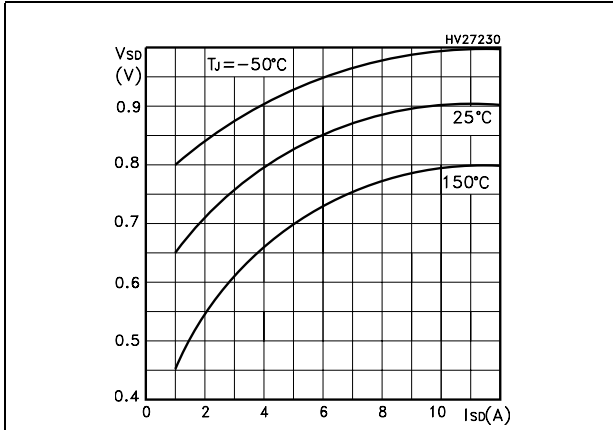
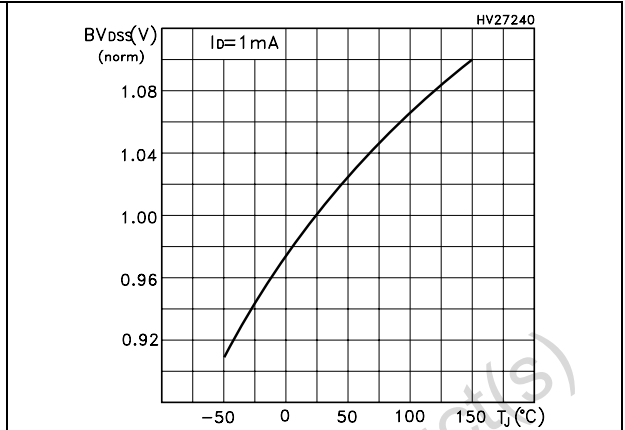


Figure 14. Normalized BV_{DSS} vs temperature



Obsolete Product(s) - Obsolete Product(s)

3 Test circuit

Figure 15. Switching times test circuit for resistive load

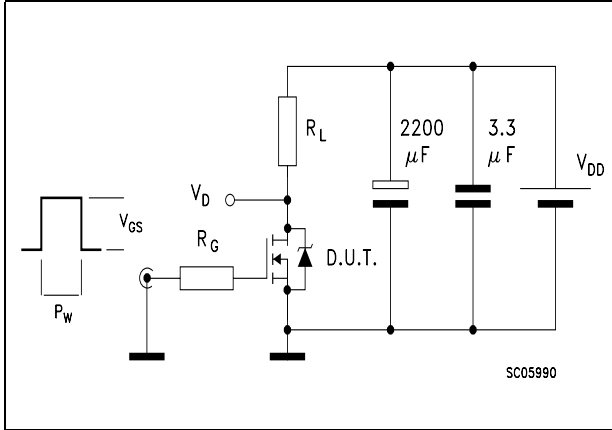


Figure 16. Gate charge test circuit

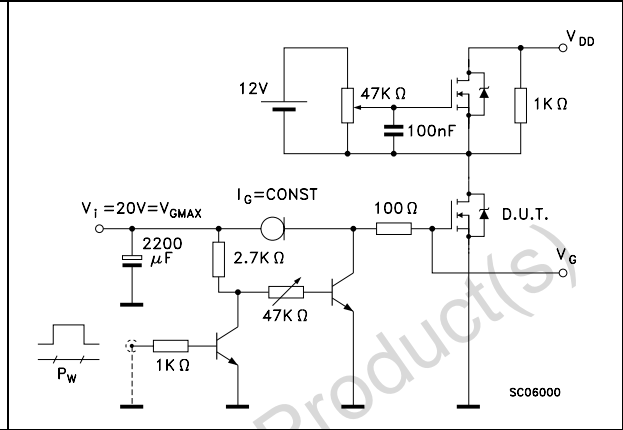


Figure 17. Test circuit for inductive load switching and diode recovery times

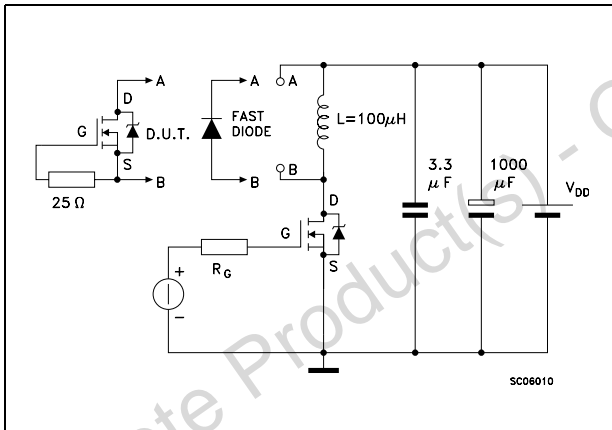


Figure 18. Unclamped Inductive load test circuit

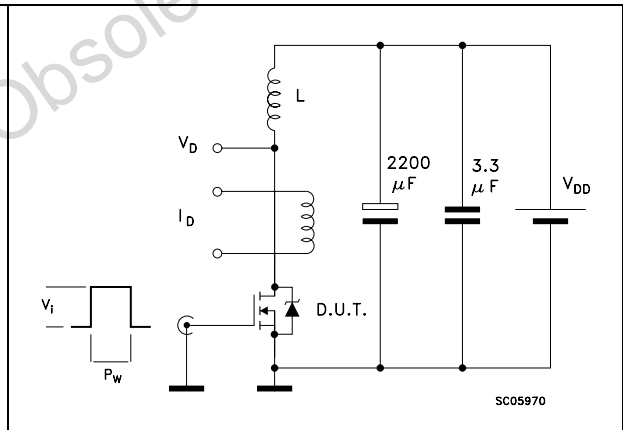


Figure 19. Unclamped inductive waveform

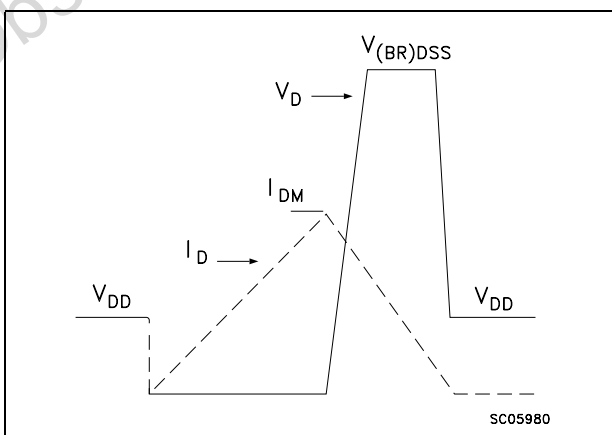
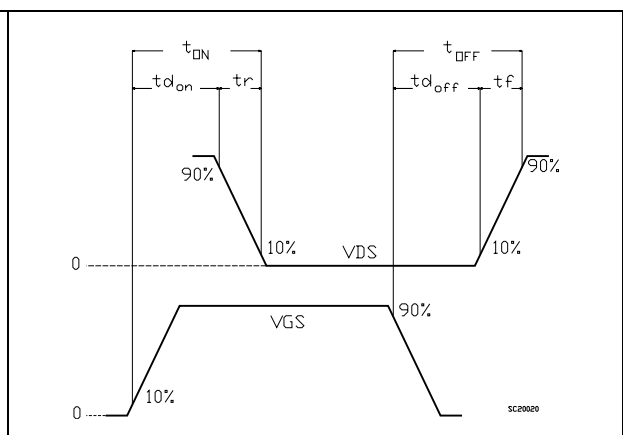


Figure 20. Switching time waveform



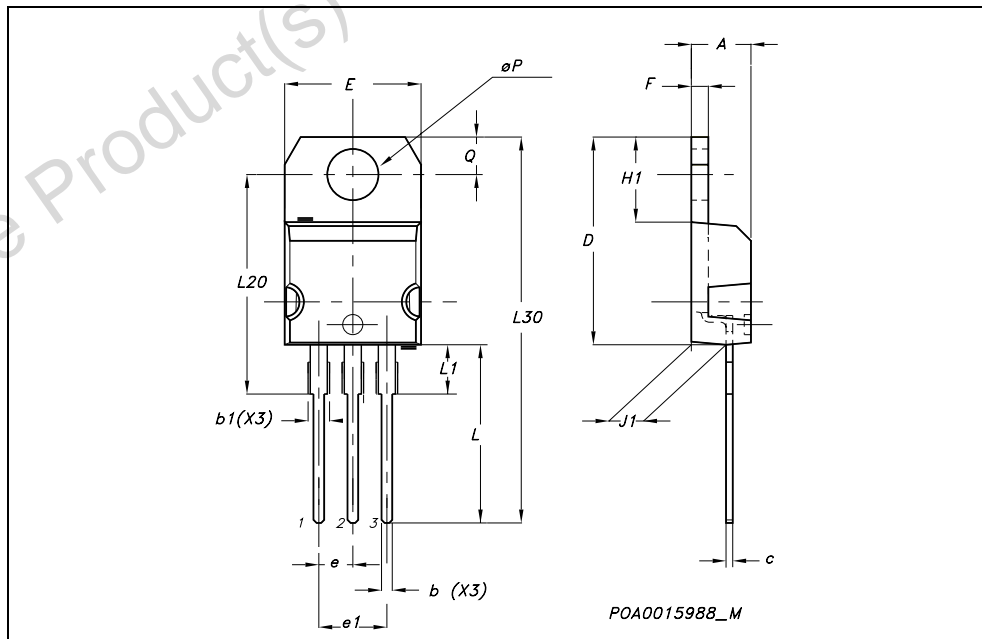
4 Package mechanical data

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

Obsolete Product(s) - Obsolete Product(s)

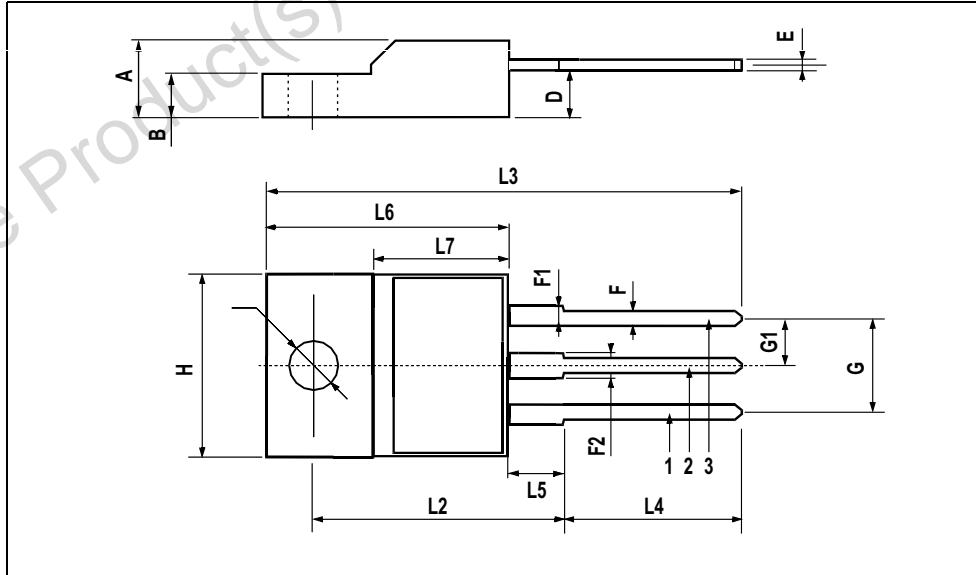
TO-220 MECHANICAL DATA

| 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 |



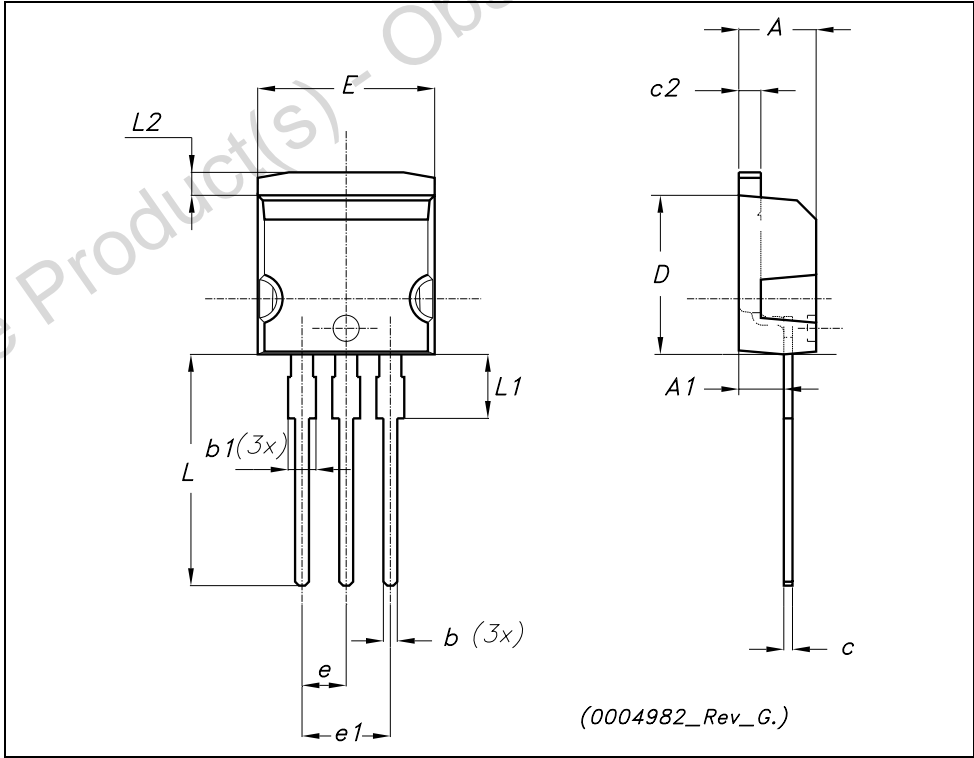
TO-220FP MECHANICAL DATA

| 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 |



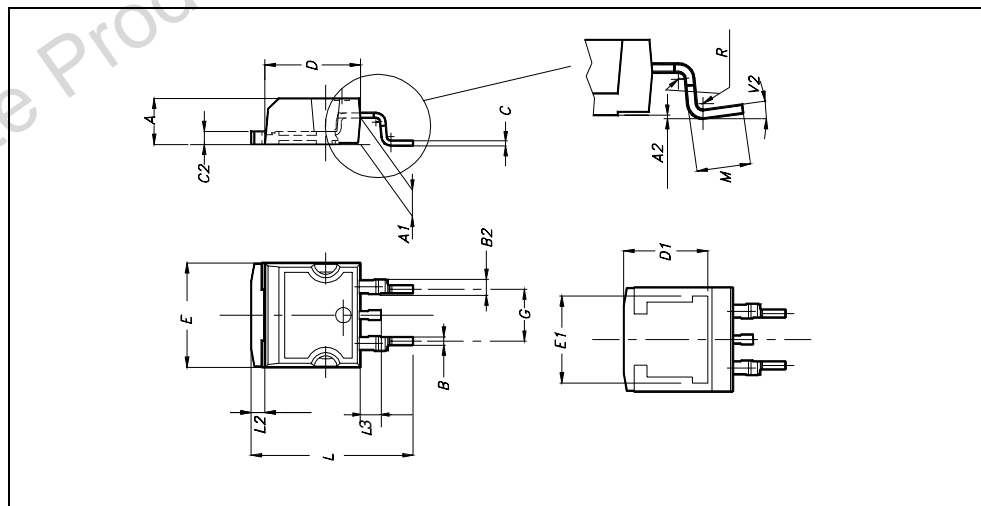
TO-262 (I²PAK) MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|------|-------|-------|------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| A1 | 2.40 | | 2.72 | 0.094 | | 0.107 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| c2 | 1.23 | | 1.32 | 0.048 | | 0.052 |
| D | 8.95 | | 9.35 | 0.352 | | 0.368 |
| e | 2.40 | | 2.70 | 0.094 | | 0.106 |
| e1 | 4.95 | | 5.15 | 0.194 | | 0.202 |
| E | 10 | | 10.40 | 0.393 | | 0.410 |
| L | 13 | | 14 | 0.511 | | 0.551 |
| L1 | 3.50 | | 3.93 | 0.137 | | 0.154 |
| L2 | 1.27 | | 1.40 | 0.050 | | 0.055 |



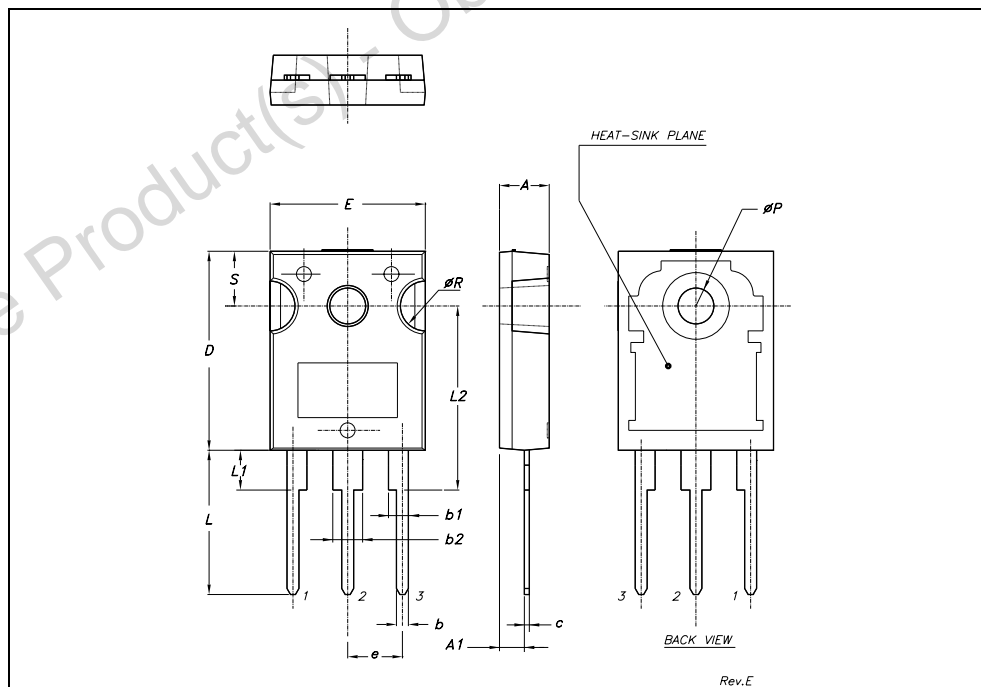
D²PAK MECHANICAL DATA

| 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° | | | |



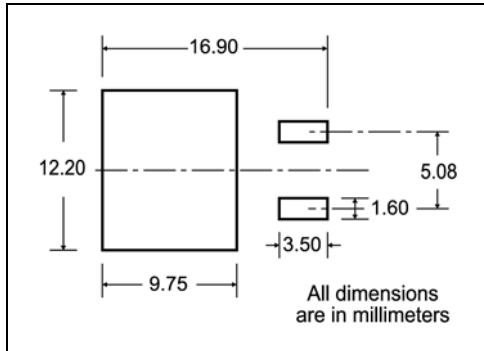
TO-247 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|-------|-------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.85 | | 5.15 | 0.19 | | 0.20 |
| A1 | 2.20 | | 2.60 | 0.086 | | 0.102 |
| b | 1.0 | | 1.40 | 0.039 | | 0.055 |
| b1 | 2.0 | | 2.40 | 0.079 | | 0.094 |
| b2 | 3.0 | | 3.40 | 0.118 | | 0.134 |
| c | 0.40 | | 0.80 | 0.015 | | 0.03 |
| D | 19.85 | | 20.15 | 0.781 | | 0.793 |
| E | 15.45 | | 15.75 | 0.608 | | 0.620 |
| e | | 5.45 | | | 0.214 | |
| L | 14.20 | | 14.80 | 0.560 | | 0.582 |
| L1 | 3.70 | | 4.30 | 0.14 | | 0.17 |
| L2 | | 18.50 | | | 0.728 | |
| øP | 3.55 | | 3.65 | 0.140 | | 0.143 |
| øR | 4.50 | | 5.50 | 0.177 | | 0.216 |
| S | | 5.50 | | | 0.216 | |



5 Packing mechanical data

D²PAK 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

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 |

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 |

10 pitches cumulative tolerance on tape +/- 0.2 mm

TOP COVER TAPE

Center line of cavity

User Direction of Feed

TRL

FEED DIRECTION

Bending radius R min.

* on sales type

6 Revision history

Table 7. Revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 29-Sep-2005 | 1 | First release |
| 05-Oct-2005 | 2 | Symbol changed on <i>Dynamic</i> |
| 19-Oct-2005 | 3 | Changed <i>Figure 8: Static drain-source on resistance</i> |
| 29-Nov-2005 | 4 | Modified <i>Figure 5: Output characteristics</i> |
| 20-Nov-2006 | 5 | Modified <i>Figure 8: Static drain-source on resistance</i> |
| 19-Jan-2007 | 6 | Typo mistake on <i>Table 5</i> . |

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