



THE DATASHEET OF STW25NM60N





STB25NM60Nx - STF25NM60N STP25NM60N - STW25NM60N

N-channel 600 V, 0.130 Ω , 21 A, MDmesh™ II Power MOSFET
TO-220, TO-220FP, I²PAK, D²PAK, TO-247

Features

| Type | V _{DSS} (@T _{jmax}) | R _{DS(on)} max | I _D |
|--------------|---|----------------------------|---------------------|
| STB25NM60N | 650 V | < 0.160 Ω | 21 A |
| STB25NM60N-1 | 650 V | < 0.160 Ω | 21 A |
| STF25NM60N | 650 V | < 0.160 Ω | 21 A ⁽¹⁾ |
| STP25NM60N | 650 V | < 0.160 Ω | 21 A |
| STW25NM60N | 650 V | < 0.160 Ω | 21 A |

1. Limited only by maximum temperature allowed

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

Application

- Switching applications

Description

This series of devices is realized with the second generation of MDmesh™ technology. This revolutionary 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

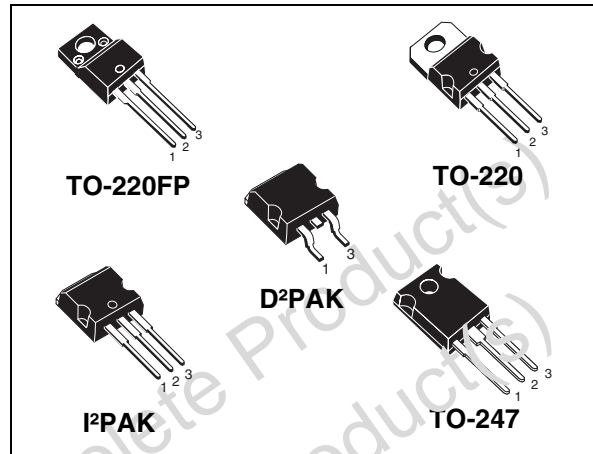


Figure 1. Internal schematic diagram

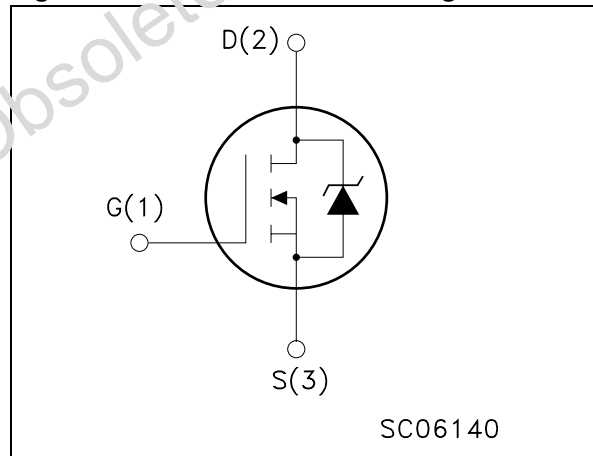


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|--------------|----------|--------------------|---------------|
| STB25NM60N | B25NM60N | D ² PAK | Tape and reel |
| STB25NM60N-1 | B25NM60N | I ² PAK | Tube |
| STF25NM60N | F25NM60N | TO-220FP | Tube |
| STP25NM60N | P25NM60N | TO-220 | Tube |
| STW25NM60N | W25NM60N | TO-247 | Tube |

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Obsolete Product(s) - Obsolete Product(s)
Obsolete Product(s) - Obsolete Product(s)

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|--|--|-------------------|------|
| | | TO-220 - I ² PAK D ² PAK - TO-247 | TO-220FP | |
| V _{DS} | Drain-source voltage (V _{GS} = 0) | 600 | | V |
| V _{GS} | Gate- source voltage | ±25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 21 | 21 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 13 | 13 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 84 | 84 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 160 | 40 | W |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C) | -- | 2500 | V |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 15 | | V/ns |
| T _{stg} | Storage temperature | -55 to 150 | | °C |
| T _j | Max. operating junction temperature | 150 | | °C |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 21 A, di/dt ≤ 400 A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 3. Thermal data

| Symbol | Parameter | Value | | | | | Unit |
|-----------------------|--|--------|--------------------|--------------------|--------|----------|------|
| | | TO-220 | I ² PAK | D ² PAK | TO-247 | TO-220FP | |
| R _{thj-case} | Thermal resistance junction-case max | 0.78 | | | | 3.1 | °C/W |
| R _{thj-pcb} | Thermal resistance junction-pcb max | -- | -- | 30 | -- | -- | |
| R _{thj-amb} | Thermal resistance junction-ambient max | 62.5 | -- | 50 | 62.5 | | °C/W |
| T _l | Maximum lead temperature for soldering purpose | 300 | | | | | °C |

Table 4. Avalanche characteristics

| 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 °C, I _D =I _{AR} , V _{DD} = 50 V) | 850 | mJ |

2 Electrical characteristics

($T_{CASE} = 25\text{ °C}$ unless otherwise specified)

Table 5. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|---|------|-------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 600 | | | V |
| $dv/dt^{(1)}$ | Drain source voltage slope | $V_{DD} = 480\text{ V}$, $I_D = 21\text{ A}$, $V_{GS} = 10\text{ V}$ | | 48 | | V/ns |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}$, @125 °C | | | 1 100 | μA μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20\text{ V}$ | | | 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10\text{ V}$, $I_D = 10.5\text{ A}$ | | 0.130 | 0.160 | Ω |

1. Characteristic value at turn off on inductive load

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|---|------|------|------|----------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS}=15\text{ V}$, $I_D=11\text{ A}$ | | 17 | | S |
| C_{iss} | Input capacitance | $V_{DS} = 50\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | | 2400 | | pF |
| C_{oss} | Output capacitance | | | 200 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 25 | | pF |
| $C_{oss\text{ eq.}}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0$, $V_{DS} = 0\text{ to }480\text{ V}$ | | 310 | | pF |
| Q_g | Total gate charge | $V_{DD} = 480\text{ V}$, $I_D = 21\text{ A}$, $V_{GS} = 10\text{ V}$, <i>(see Figure 19)</i> | | 84 | | nC |
| Q_{gs} | Gate-source charge | | | 14 | | nC |
| Q_{gd} | Gate-drain charge | | | 44 | | nC |
| R_g | Gate input resistance | f=1 MHz Gate DC Bias=0 Test signal level=20 mV 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_{DS}

Table 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 300\text{ V}$, $I_D = 10\text{ A}$ $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 18) | | 24.5 | | ns |
| t_r | Rise time | | | 18 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 94 | | ns |
| t_f | Fall time | | | 24 | | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------|-------------------------------|---|-----|------|-----|---------------|
| I_{SD} | Source-drain current | | | | 21 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 84 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 21\text{ A}$, $V_{GS} = 0$ | | | 1.3 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 21\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | | 427 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$ | | 7.2 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 23) | | 33.6 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 21\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | | 526 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ | | 9.1 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 23) | | 34.5 | | 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 2. Safe operating area for TO-220 / D²PAK / I²PAK

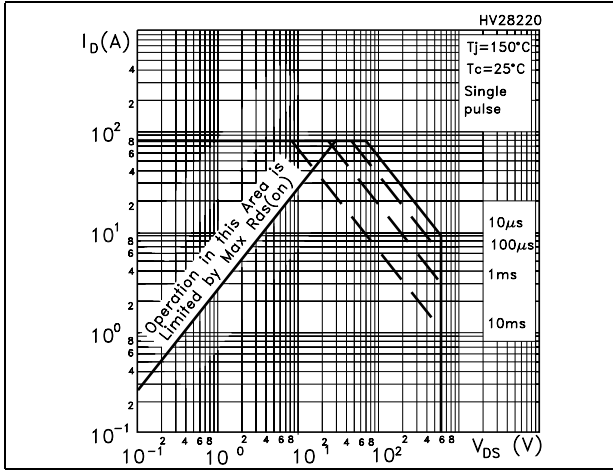


Figure 3. Thermal impedance for TO-220 / D²PAK / I²PAK

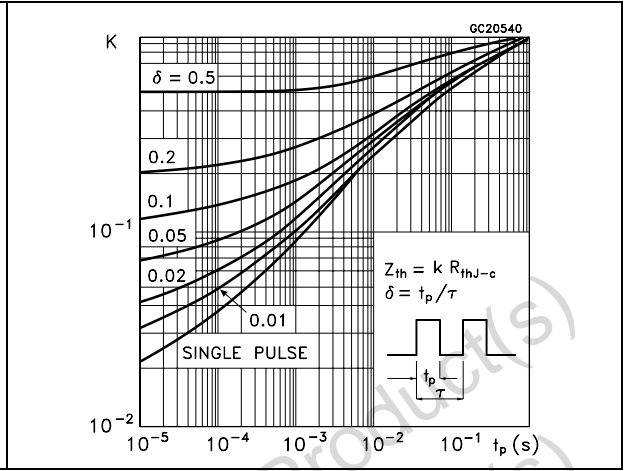


Figure 4. Safe operating area for TO-220FP

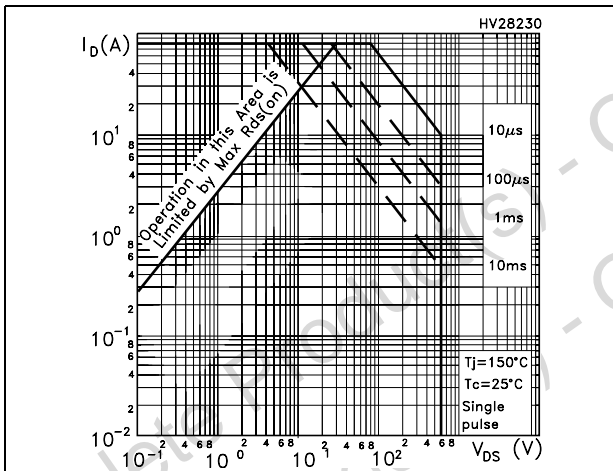


Figure 5. Thermal impedance for TO-220FP

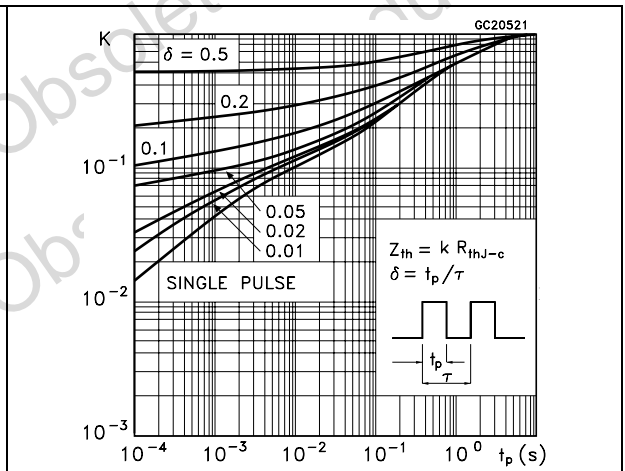


Figure 6. Safe operating area for TO-247

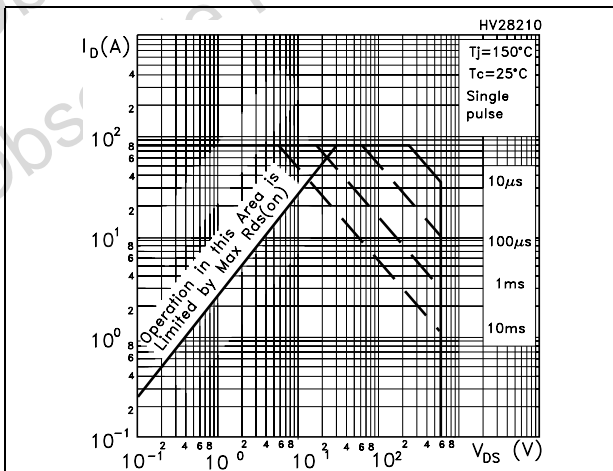


Figure 7. Thermal impedance for TO-247

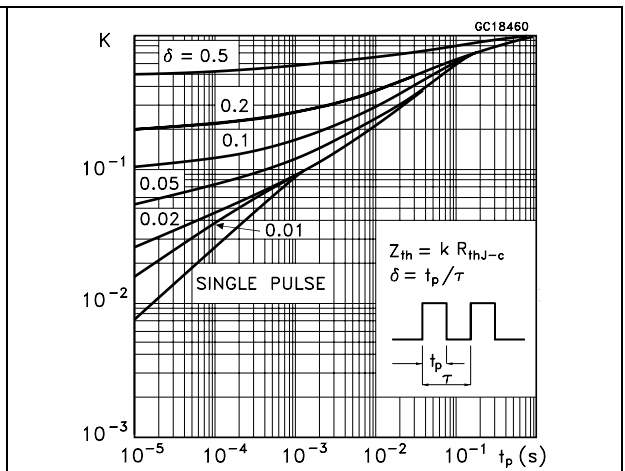


Figure 8. Output characteristics

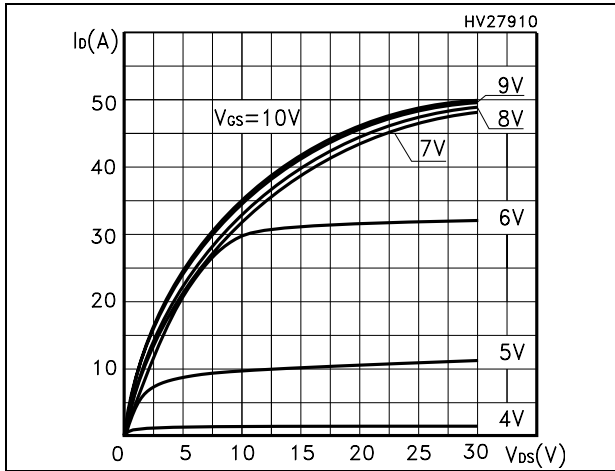


Figure 9. Transfer characteristics

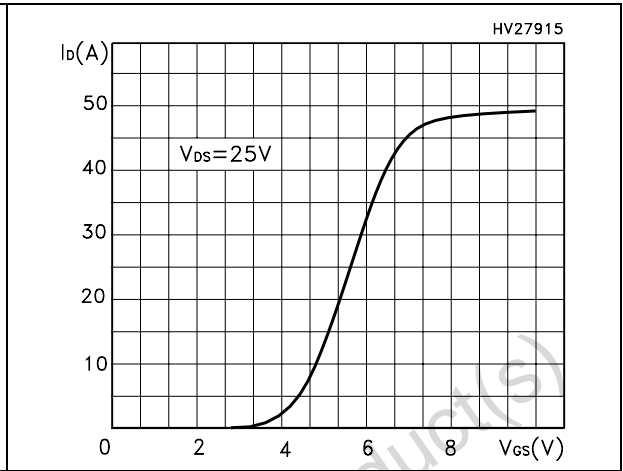


Figure 10. Transconductance

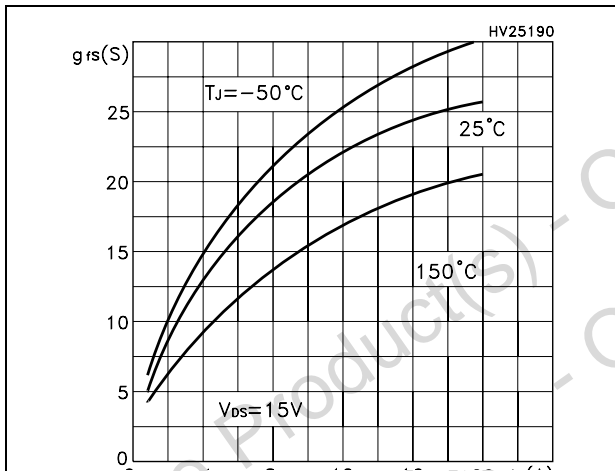


Figure 11. Static drain-source on resistance

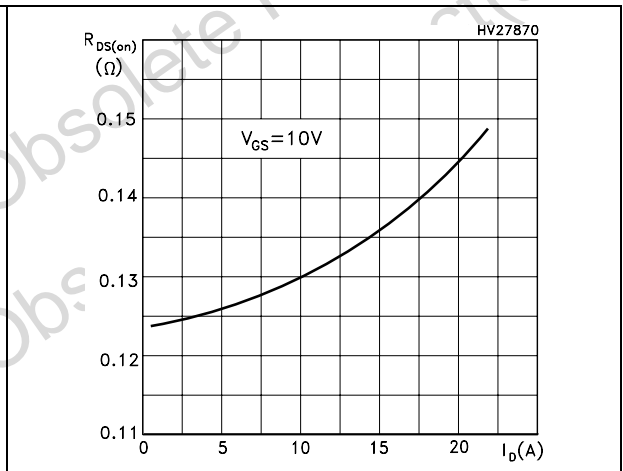


Figure 12. Gate charge vs gate-source voltage

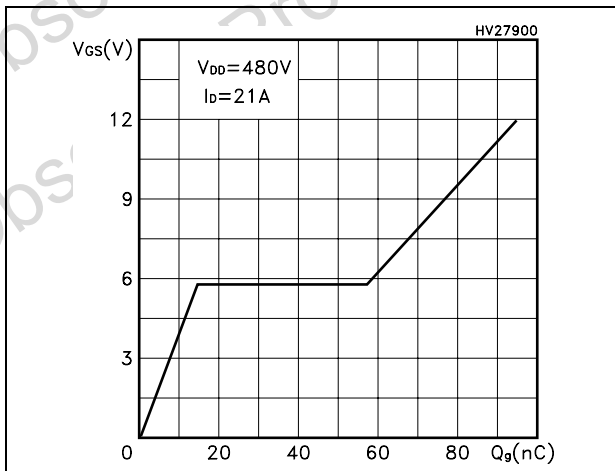


Figure 13. Capacitance variations

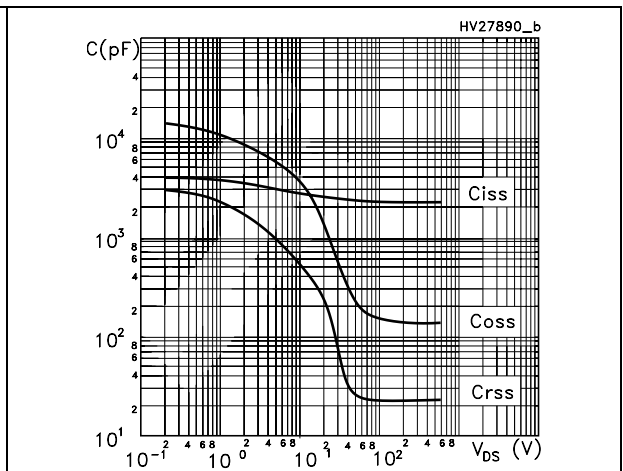


Figure 14. Normalized gate threshold voltage vs temperature

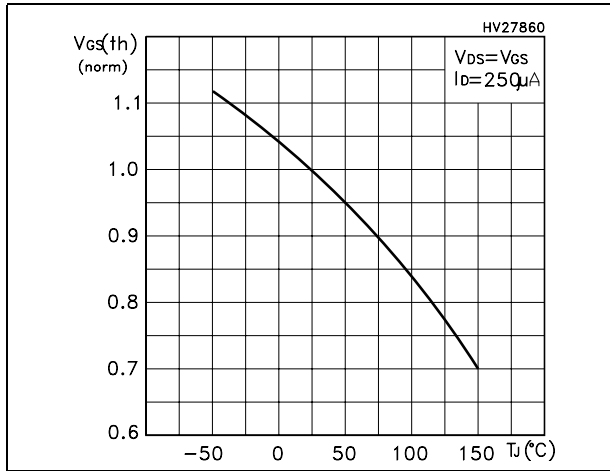


Figure 15. Normalized on resistance vs temperature

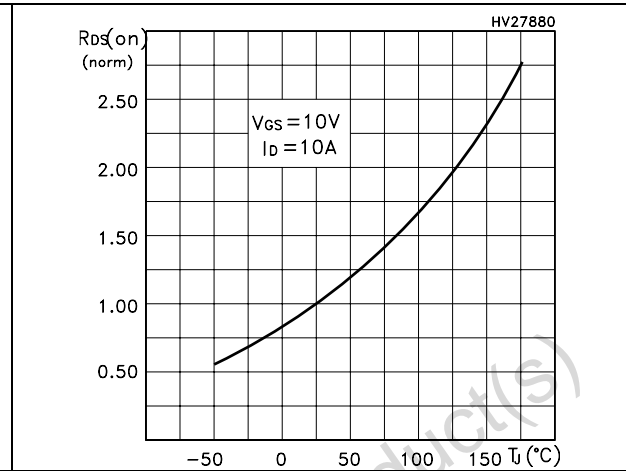


Figure 16. Source-drain diode forward characteristics

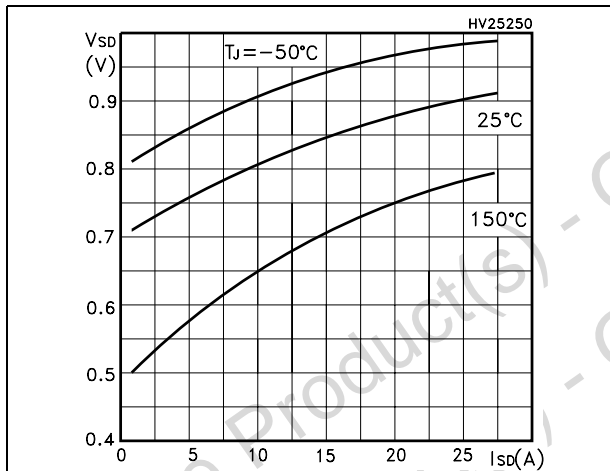
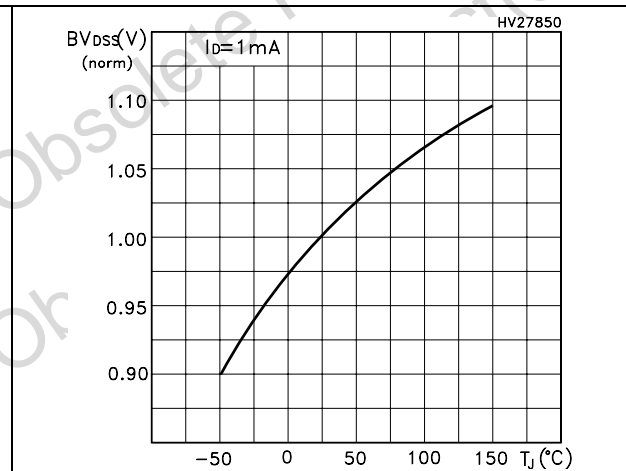


Figure 17. Normalized BV_{DSS} vs temperature



3 Test circuit

Figure 18. Switching times test circuit for resistive load



Figure 19. Gate charge test circuit

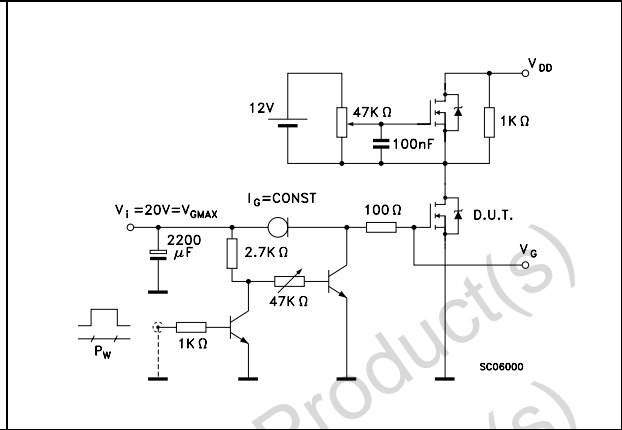


Figure 20. Test circuit for inductive load switching and diode recovery times

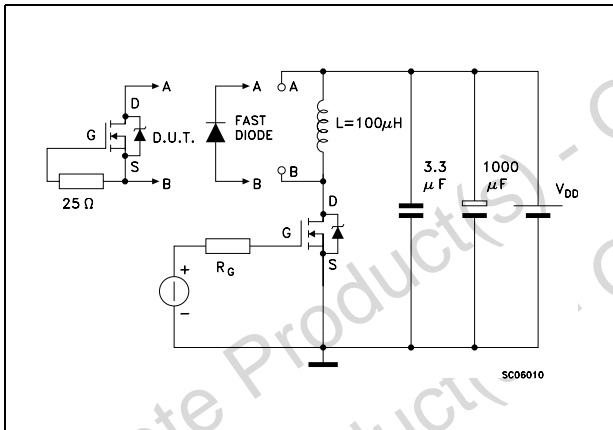


Figure 21. Unclamped Inductive load test circuit

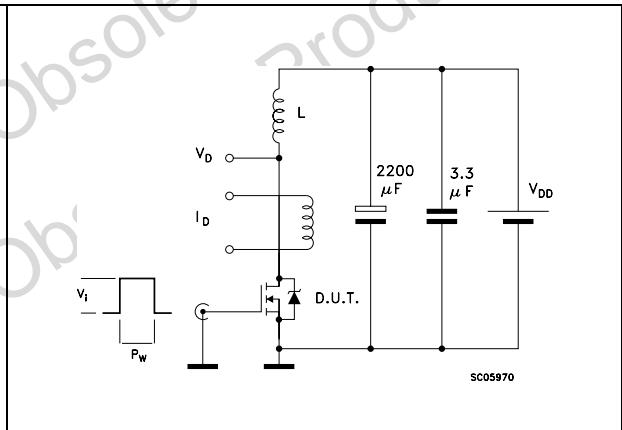


Figure 22. Unclamped inductive waveform

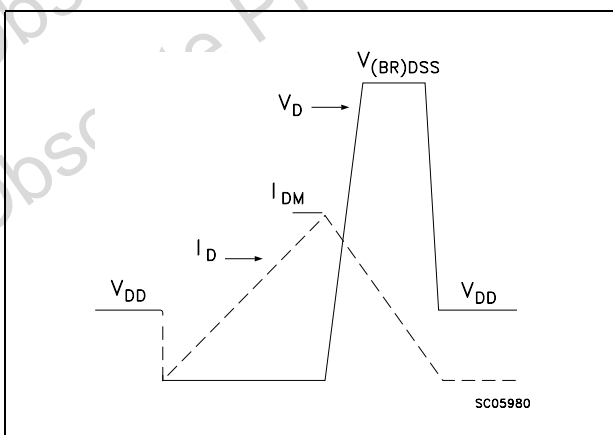
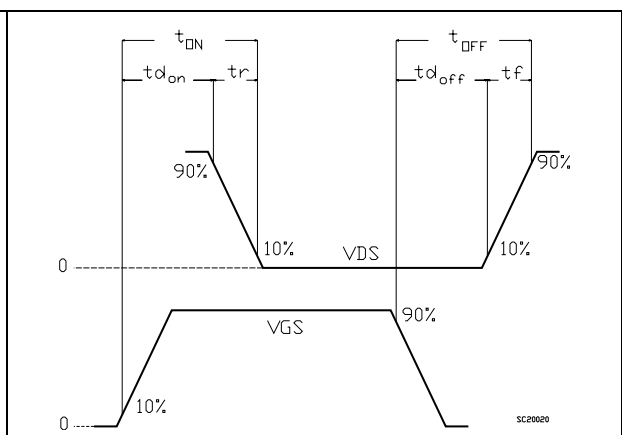


Figure 23. Switching time waveform



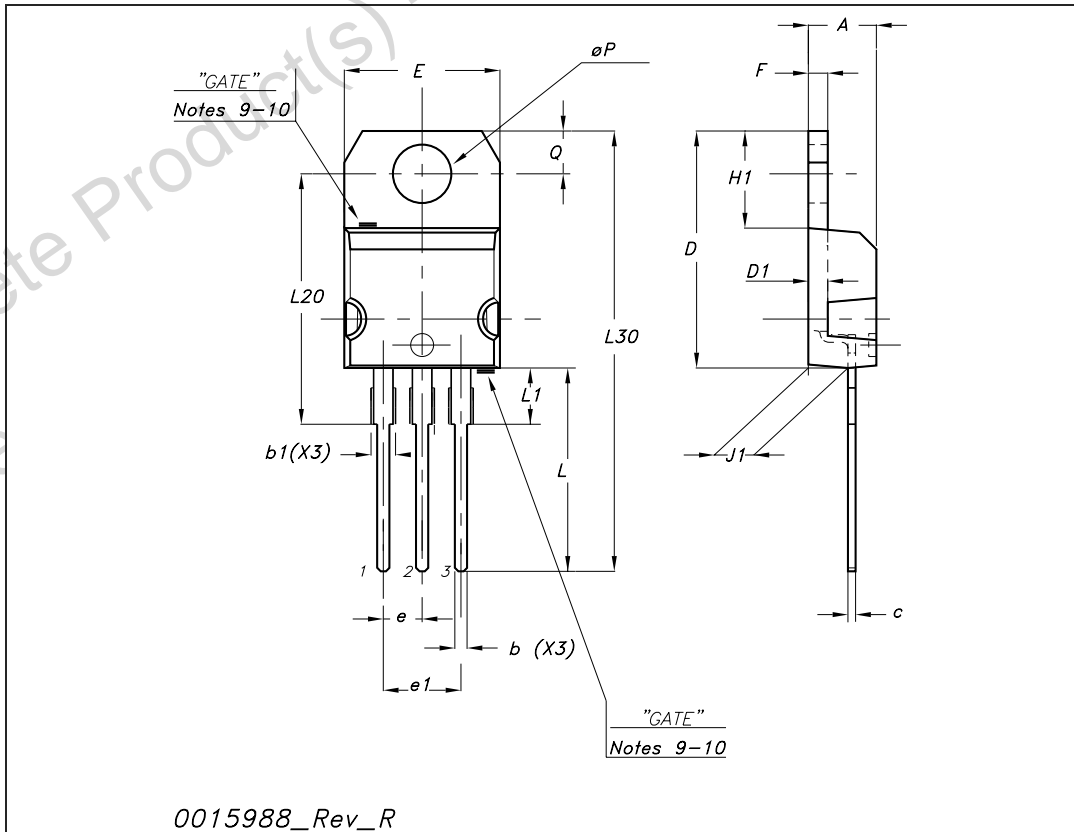
4 Package mechanical data

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)
Obsolete Product(s) - Obsolete Product(s)

TO-220 mechanical data

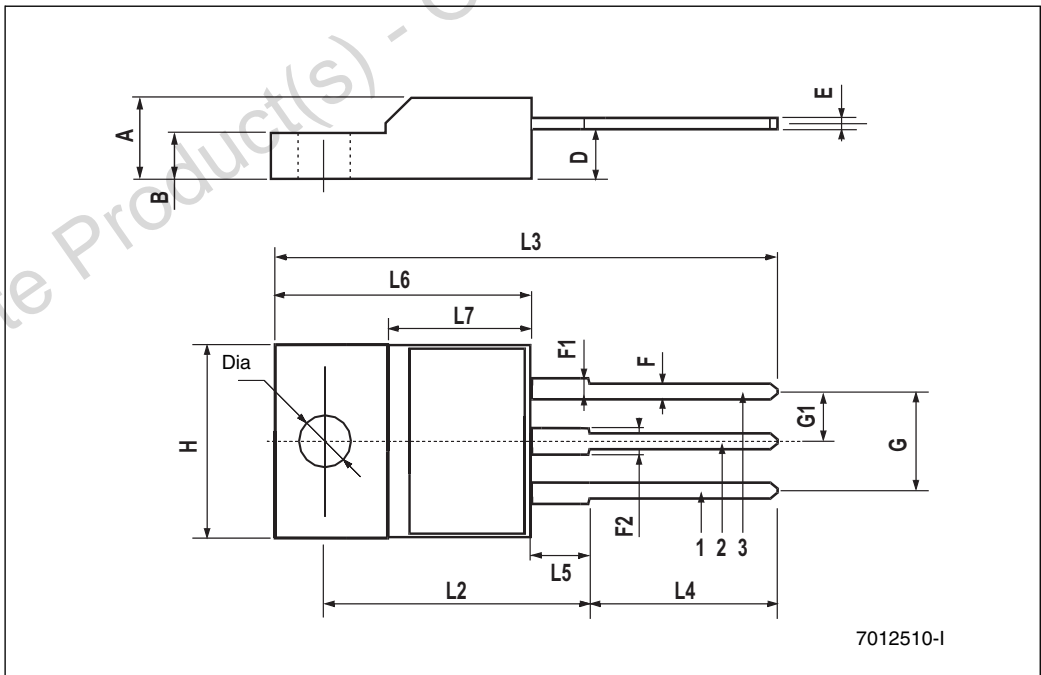
| Dim | mm | | | inch | | |
|-----|-------|-------|-------|-------|-------|-------|
| | Min | Typ | Max | Min | Typ | Max |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.48 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 15.75 | 0.6 | | 0.62 |
| D1 | | 1.27 | | | 0.050 | |
| 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 | | 0.051 |
| 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 | |
| ∅P | 3.75 | | 3.85 | 0.147 | | 0.151 |
| Q | 2.65 | | 2.95 | 0.104 | | 0.116 |



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TO-220FP mechanical data

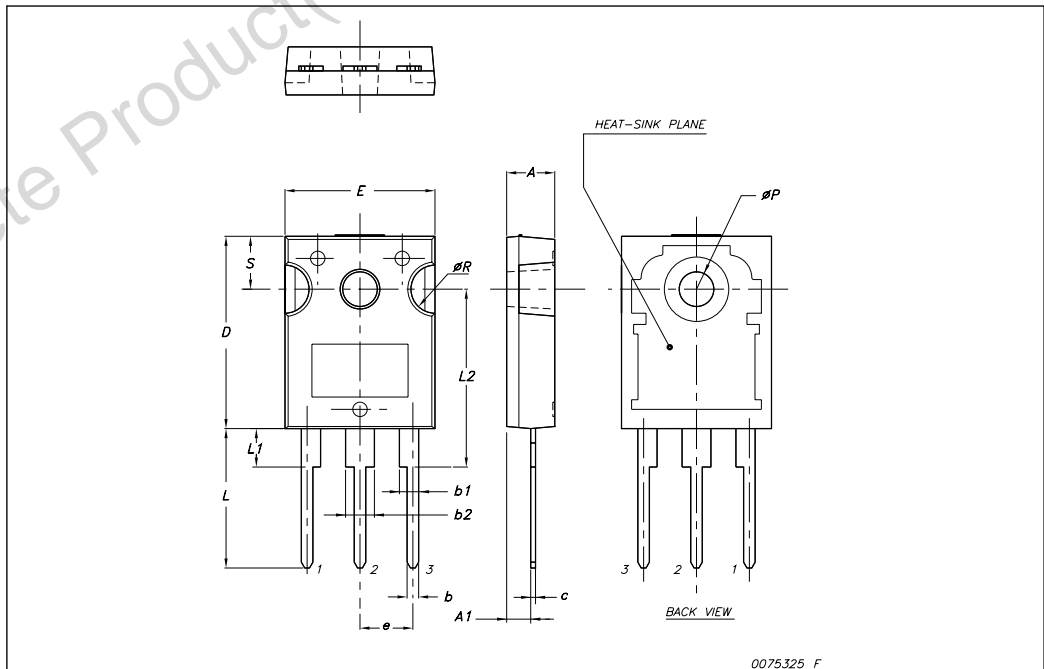
| Dim. | mm. | | | inch | | |
|------|-------|-----|-------|-------|-------|-------|
| | Min. | Typ | Max. | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| B | 2.5 | | 2.7 | 0.098 | | 0.106 |
| D | 2.5 | | 2.75 | 0.098 | | 0.108 |
| E | 0.45 | | 0.70 | 0.017 | | 0.027 |
| F | 0.75 | | 1.00 | 0.030 | | 0.039 |
| F1 | 1.15 | | 1.50 | 0.045 | | 0.067 |
| F2 | 1.15 | | 1.50 | 0.045 | | 0.067 |
| G | 4.95 | | 5.20 | 0.195 | | 0.204 |
| G1 | 2.40 | | 2.70 | 0.094 | | 0.106 |
| H | 10 | | 10.40 | 0.393 | | 0.409 |
| L2 | | 16 | | | 0.630 | |
| L3 | 28.6 | | 30.6 | 1.126 | | 1.204 |
| L4 | 9.80 | | 10.60 | 0.385 | | 0.417 |
| L5 | 2.9 | | 3.6 | 0.114 | | 0.141 |
| L6 | 15.90 | | 16.40 | 0.626 | | 0.645 |
| L7 | 9 | | 9.30 | 0.354 | | 0.366 |
| Dia | 3 | | 3.2 | 0.118 | | 0.126 |



7012510-1

TO-247 Mechanical data

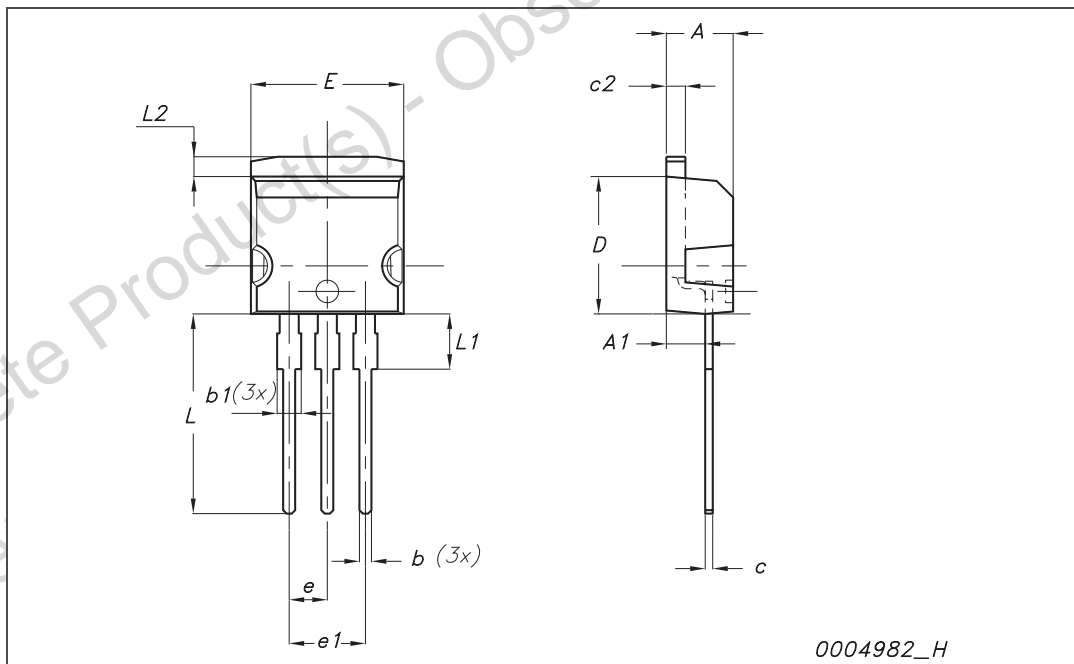
| Dim. | mm. | | |
|------|-------|-------|-------|
| | Min. | Typ | Max. |
| A | 4.85 | | 5.15 |
| A1 | 2.20 | | 2.60 |
| b | 1.0 | | 1.40 |
| b1 | 2.0 | | 2.40 |
| b2 | 3.0 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.85 | | 20.15 |
| E | 15.45 | | 15.75 |
| e | | 5.45 | |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| øP | 3.55 | | 3.65 |
| øR | 4.50 | | 5.50 |
| S | | 5.50 | |



0075.325 F

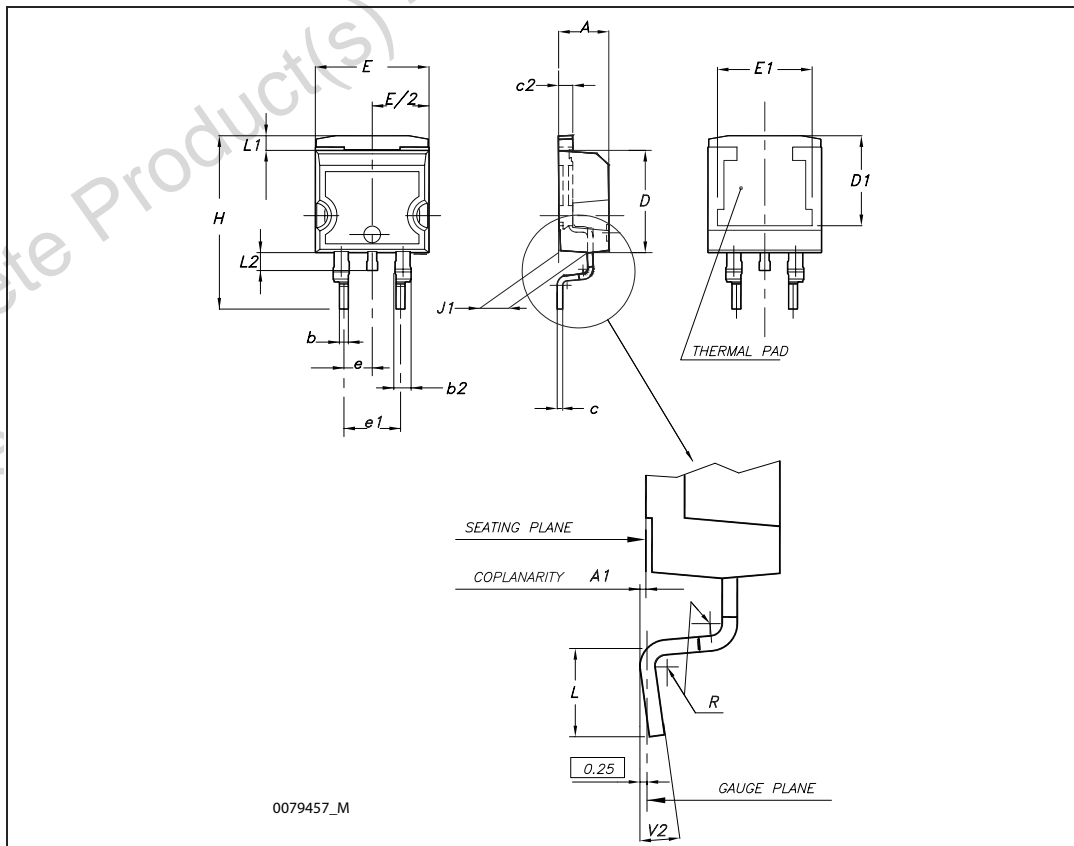
I²PAK (TO-262) mechanical data

| 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 (TO-263) mechanical data

| Dim | mm | | | inch | | |
|-----|------|------|-------|-------|-------|-------|
| | Min | Typ | Max | Min | Typ | Max |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| A1 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| b | 0.70 | | 0.93 | 0.027 | | 0.037 |
| b2 | 1.14 | | 1.70 | 0.045 | | 0.067 |
| c | 0.45 | | 0.60 | 0.017 | | 0.024 |
| c2 | 1.23 | | 1.36 | 0.048 | | 0.053 |
| D | 8.95 | | 9.35 | 0.352 | | 0.368 |
| D1 | 7.50 | | | 0.295 | | |
| E | 10 | | 10.40 | 0.394 | | 0.409 |
| E1 | 8.50 | | | 0.334 | | |
| e | | 2.54 | | | 0.1 | |
| e1 | 4.88 | | 5.28 | 0.192 | | 0.208 |
| H | 15 | | 15.85 | 0.590 | | 0.624 |
| J1 | 2.49 | | 2.69 | 0.099 | | 0.106 |
| L | 2.29 | | 2.79 | 0.090 | | 0.110 |
| L1 | 1.27 | | 1.40 | 0.05 | | 0.055 |
| L2 | 1.30 | | 1.75 | 0.051 | | 0.069 |
| R | | 0.4 | | | 0.016 | |
| V2 | 0° | | 8° | 0° | | 8° |



5 Packaging mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Tape slot in core for tape start 2.5mm min. width

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 |

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

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 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 30-Nov-2004 | 1 | First release. |
| 22-Mar-2005 | 2 | Modified title |
| 23-May-2005 | 3 | Inserted some values in Table 7 |
| 08-Jun-2005 | 4 | Inserted new row in Table 6 |
| 08-Sep-2005 | 5 | New value for $C_{oss\ eq}$ in Table 6 |
| 28-Sep-2005 | 6 | Added curves |
| 26-Oct-2005 | 7 | Complete version |
| 23-Jun-2006 | 8 | New template, new value on Absolute maximum ratings |
| 25-Aug-2006 | 9 | Wrong title on first page |
| 14-Nov-2006 | 10 | Modified Avalanche characteristics |
| 19-Jan-2007 | 11 | Typo mistake on Table 7 |
| 11-Jun-2008 | 12 | <ul style="list-style-type: none"> – Updated $R_{DS(on)}$ max value in Table 5 – Corrected capacitance value in Table 6 – Update Figure 13: Capacitance variations |

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