



STB15NM60N - STF/I15NM60N STP15NM60N - STW15NM60N

N-channel 600V - 0.270Ω - 14A - D²/I²PAK - TO-220/FP - TO-247
Second generation MDmesh™ Power MOSFET

Features

| Type | V _{DSS} (@T _{jmax}) | R _{DS(on)} | I _D |
|------------|---|---------------------|--------------------|
| STB15NM60N | 650V | < 0.299Ω | 14A |
| STI15NM60N | 650V | < 0.299Ω | 14A |
| STF15NM60N | 650V | < 0.299Ω | 14A ⁽¹⁾ |
| STP15NM60N | 650V | < 0.299Ω | 14A |
| STW15NM60N | 650V | < 0.299Ω | 14A |

1. Limited only by maximum temperature allowed

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

Description

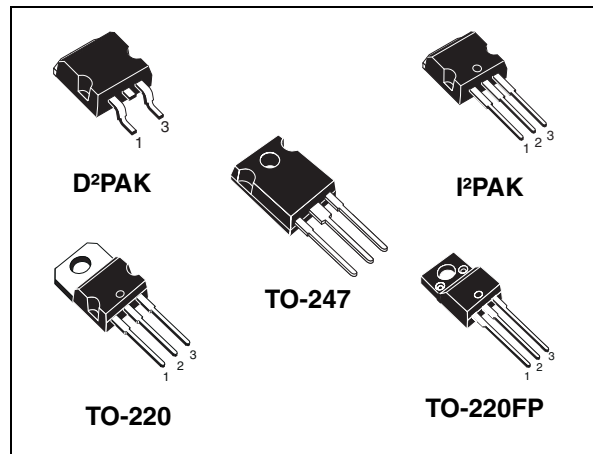
This series of devices implements the second generation of MDmesh™ Technology. This revolutionary Power MOSFET associates a new vertical structure to the Company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency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

Application

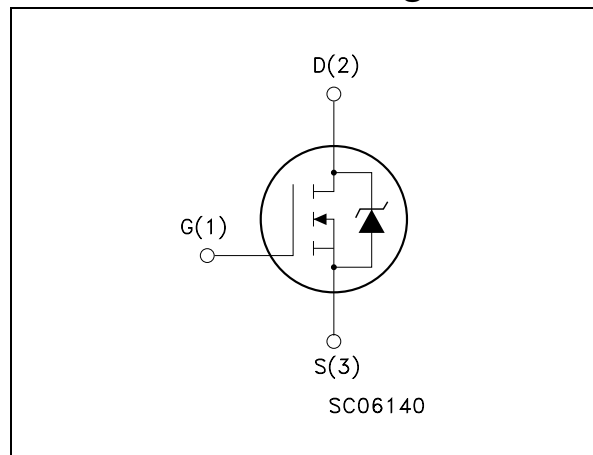
- Switching applications

Order codes

| Part number | Marking | Package | Packaging |
|-------------|----------|--------------------|-------------|
| STB15NM60N | B15NM60N | D ² PAK | Tape & reel |
| STI15NM60N | I15NM60N | I ² PAK | Tube |
| STF15NM60N | F15NM60N | TO-220FP | Tube |
| STP15NM60N | P15NM60N | TO-220 | Tube |
| STW15NM60N | W15NM60N | TO-247 | Tube |



Internal schematic diagram



Contents

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1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|------------------------------------|--|--|-------------------|------|
| | | D ² PAK/I ² PAK TO-220/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 | 14 | 14 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100°C | 9 | 9 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 56 | 56 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25°C | 125 | 30 | 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=1s; T _C =25°C) | -- | 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} ≤ 14A, di/dt ≤ 400A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 2. Thermal data

| Symbol | Parameter | D ² PAK/I ² PAK TO-220/TO-247 | TO-220FP | Unit |
|-----------------------|---|--|----------|------|
| R _{thj-case} | Thermal resistance junction-case max | 1 | 4.2 | °C/W |
| R _{thj-amb} | Thermal resistance junction-amb max | 62.5 | | °C/W |
| T _l | Maximum lead temperature for soldering purposes | 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) | 6 | A |
| E _{AS} | Single pulse avalanche energy (starting T _j =25°C, I _D =I _{AS} , V _{DD} = 50V) | 300 | 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 | $I_D = 1mA, V_{GS} = 0$ | 600 | | | V |
| $dv/dt^{(1)}$ | Drain-source voltage slope | $V_{DD} = 480V, I_D = 14A,$ $V_{GS} = 10V$ | | 30 | | V/ns |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{Max rating},$ $V_{DS} = \text{Max rating}, @ 125^{\circ}C$ | | | 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 | $V_{GS} = 10V, I_D = 7A$ | | 0.270 | 0.299 | Ω |

1. Value measured at turn off under inductive load

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|---|---|------|-------------------|------|----------------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 15V, I_D = 7A$ | | 10 | | S |
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 50V, f = 1MHz,$ $V_{GS} = 0$ | | 1250 100 10 | | pF pF pF |
| $C_{oss\ eq.}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0V \text{ to } 480V$ | | 137 | | pF |
| R_g | Gate input resistance | $f = 1MHz$ Gate DC Bias=0 Test signal level=20mV open drain | | 6.0 | | Ω |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 480V, I_D = 14A$ $V_{GS} = 10V$ (see Figure 18) | | 37 6 18 | | 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 | $V_{DD} = 300V, I_D = 7A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ <i>(see Figure 17)</i> | | 12 | | ns |
| t_r | Rise time | | | 14 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 80 | | ns |
| t_f | Fall time | | | 30 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|-----------------|-------------------------------|---|-----|-----|-----|---------|
| I_{SD} | Source-drain current | | | | 14 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 56 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 14A, V_{GS} = 0$ | | | 1.3 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 14A, di/dt = 100A/\mu s,$ $V_{DD} = 100V, T_j = 25^\circ C$ <i>(see Figure 19)</i> | | 390 | | ns |
| Q_{rr} | Reverse recovery charge | | | 5 | | μC |
| I_{RRM} | Reverse recovery current | | | 25 | | A |
| t_{rr} | Reverse recovery time | $V_{DD} = 100V$ $di/dt = 100A/\mu s, I_{SD} = 14A$ $T_j = 150^\circ C$ <i>(see Figure 19)</i> | | 500 | | ns |
| Q_{rr} | Reverse recovery charge | | | 7 | | μC |
| I_{RRM} | Reverse recovery current | | | 25 | | 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

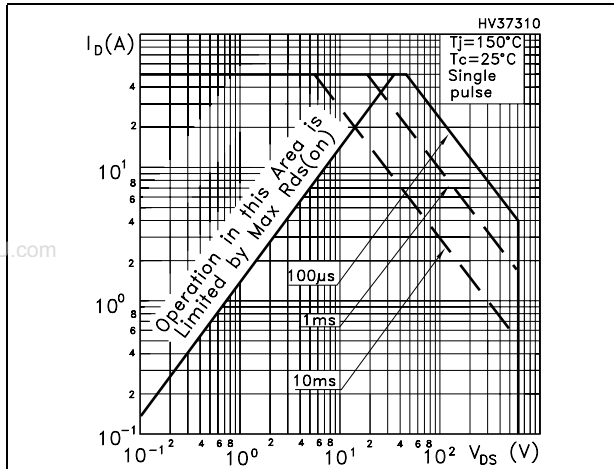


Figure 2. Thermal impedance for TO-220 / D²PAK / I²PAK

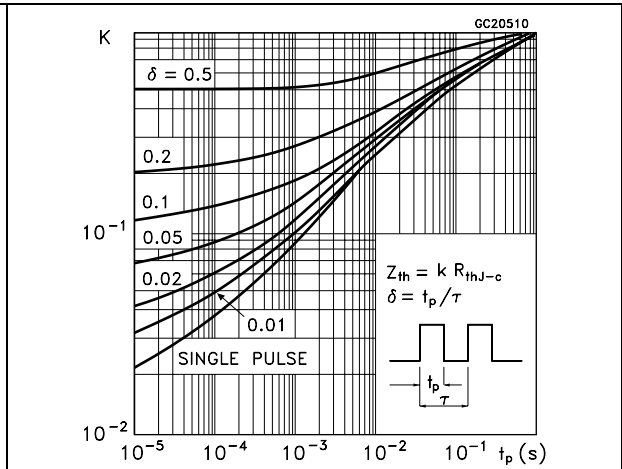


Figure 3. Safe operating area for TO-220FP

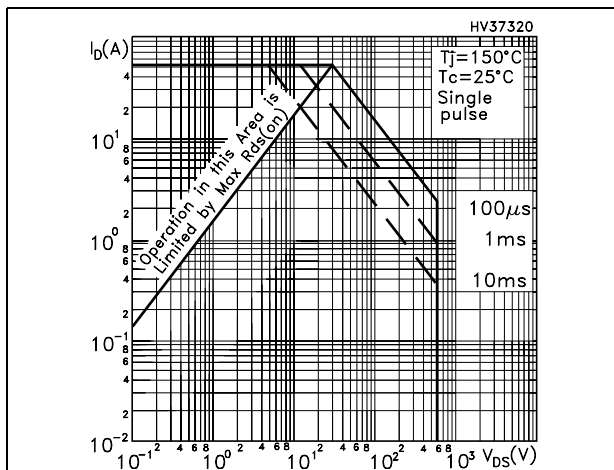


Figure 4. Thermal impedance for TO-220FP

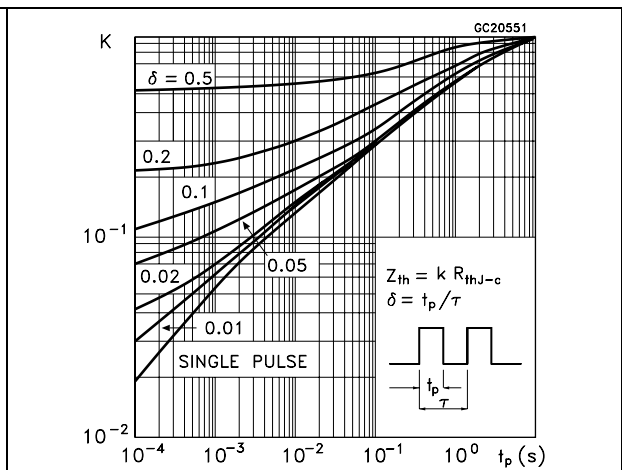


Figure 5. Safe operating area for TO-247

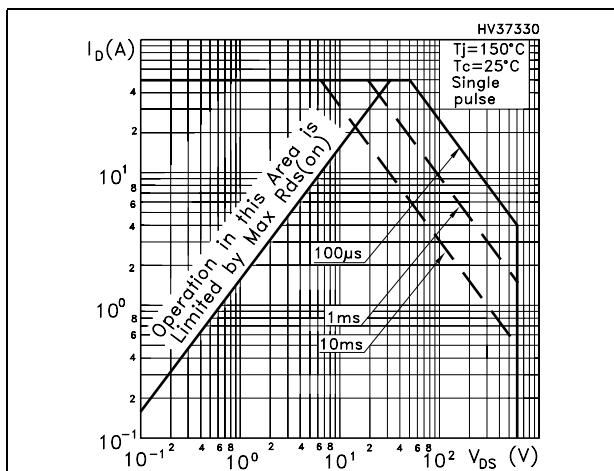


Figure 6. Thermal impedance for TO-247

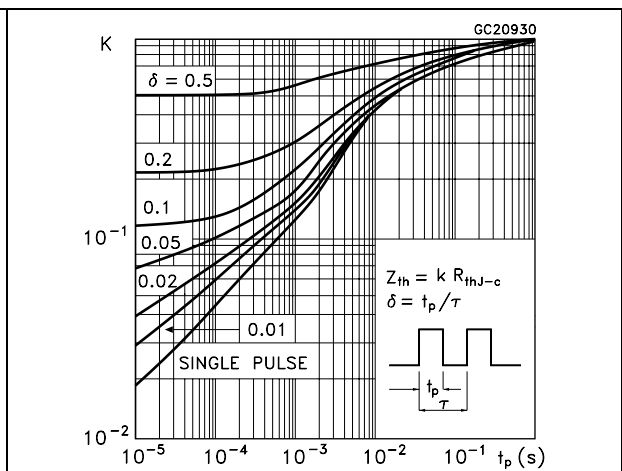


Figure 7. Output characteristics

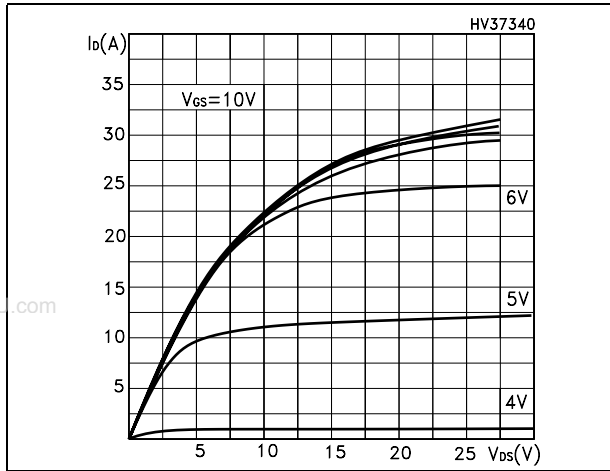


Figure 8. Transfer characteristics

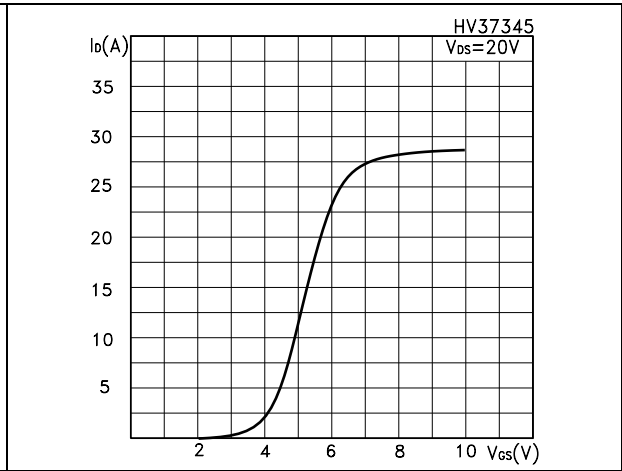


Figure 9. Transconductance

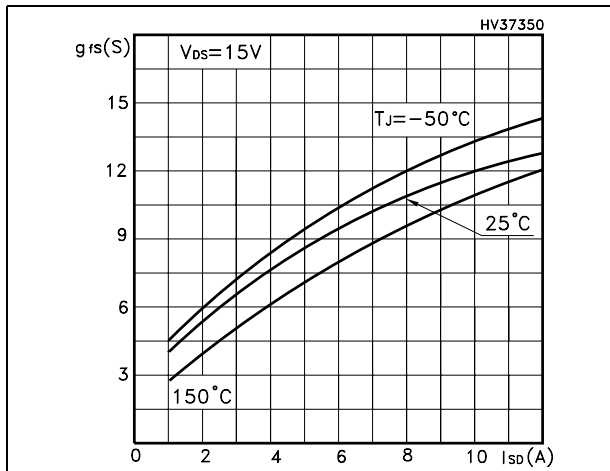


Figure 10. Static drain-source on resistance

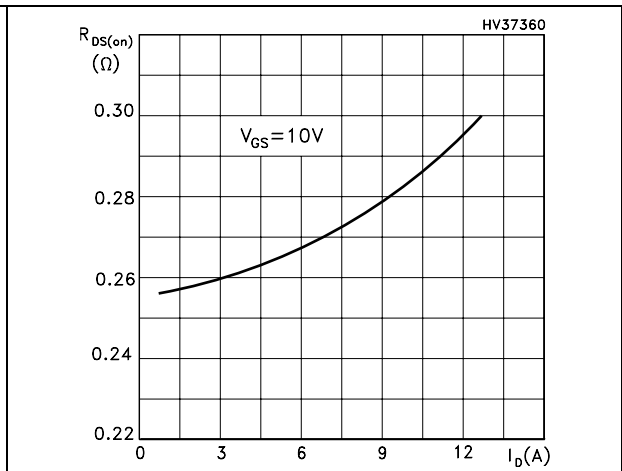


Figure 11. Gate charge vs gate-source voltage

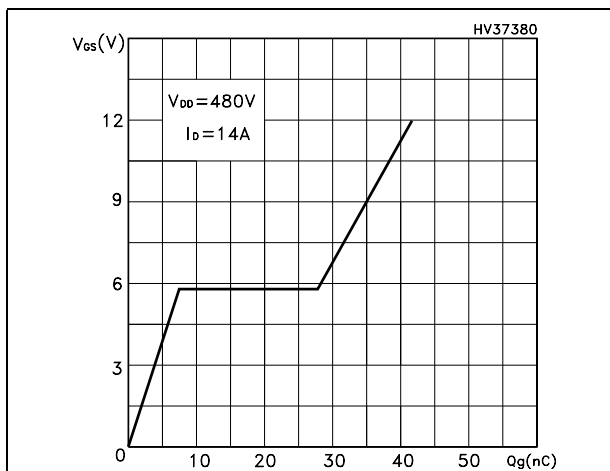


Figure 12. Capacitance variations

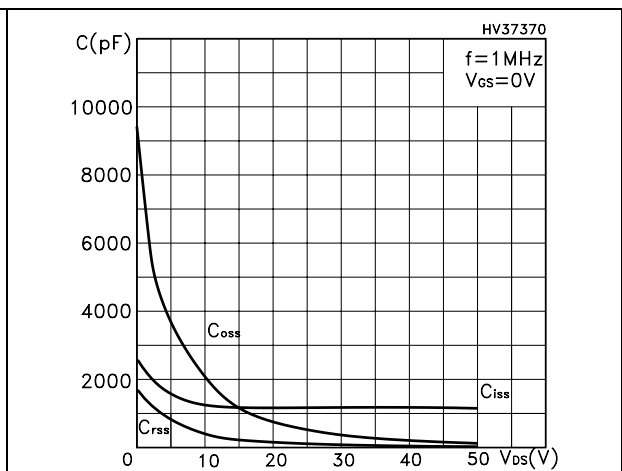


Figure 13. Normalized gate threshold voltage vs temperature

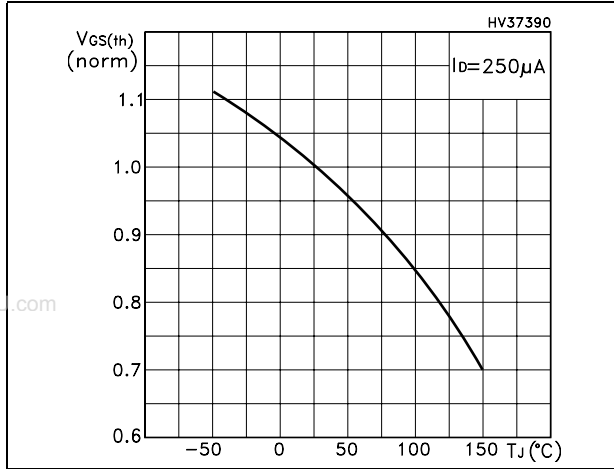


Figure 14. Normalized on resistance vs temperature

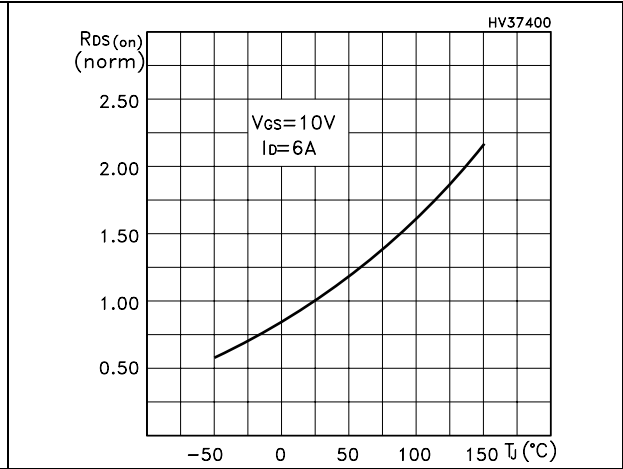


Figure 15. Source-drain diode forward characteristics

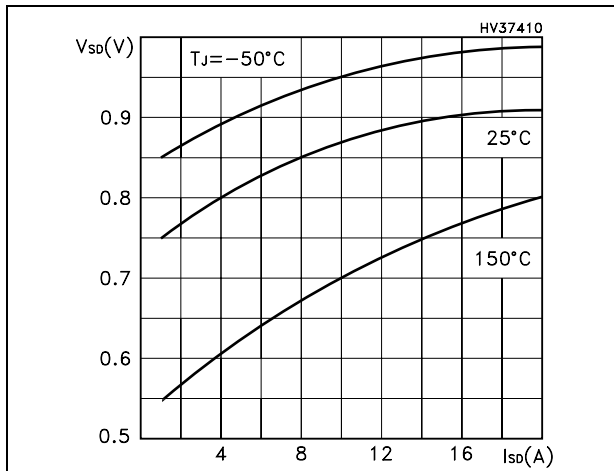
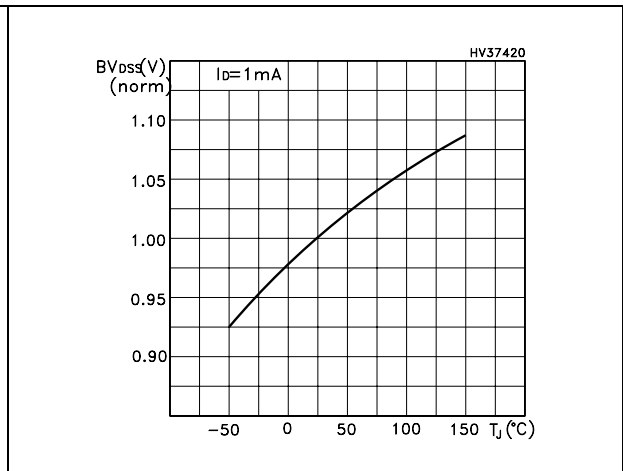


Figure 16. Normalized B_VDSS vs temperature



3 Test circuit

Figure 17. Switching times test circuit for resistive load

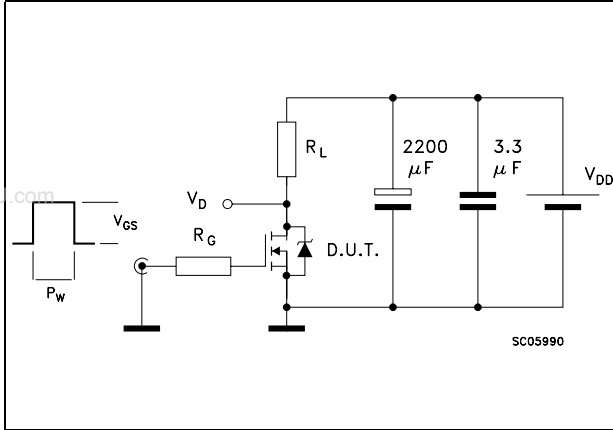


Figure 18. Gate charge test circuit



Figure 19. Test circuit for inductive load switching and diode recovery times



Figure 20. Unclamped Inductive load test circuit



Figure 21. Unclamped inductive waveform



Figure 22. Switching time waveform



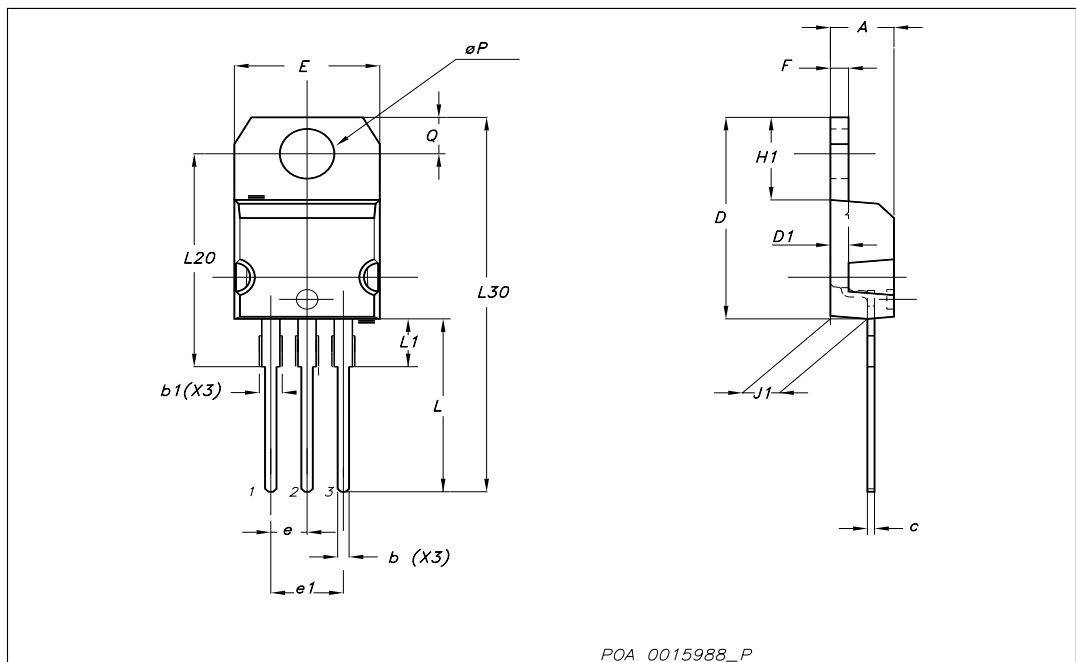
4 Package mechanical data

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 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 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 |

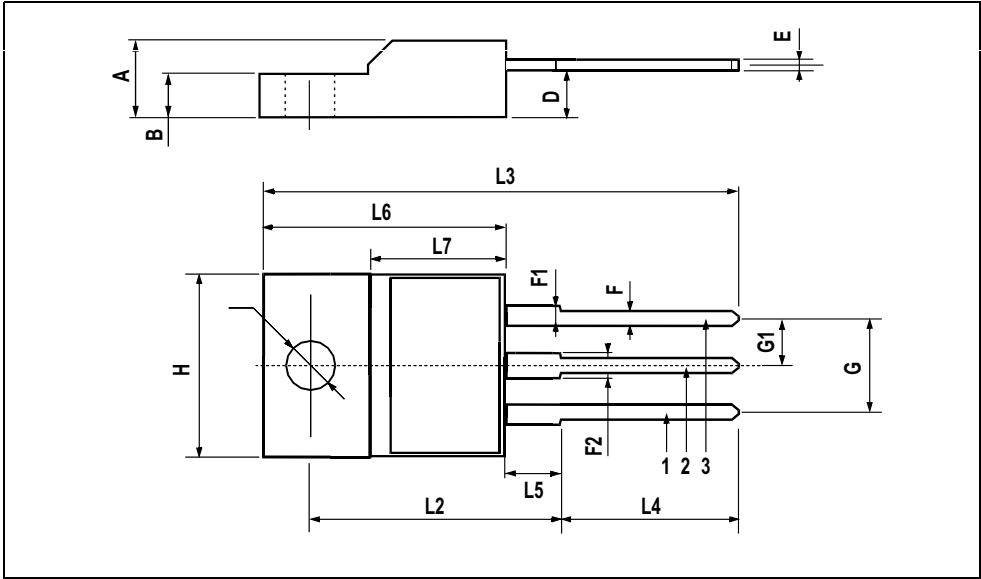
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TO-220FP MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|-----|------|-------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 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 |

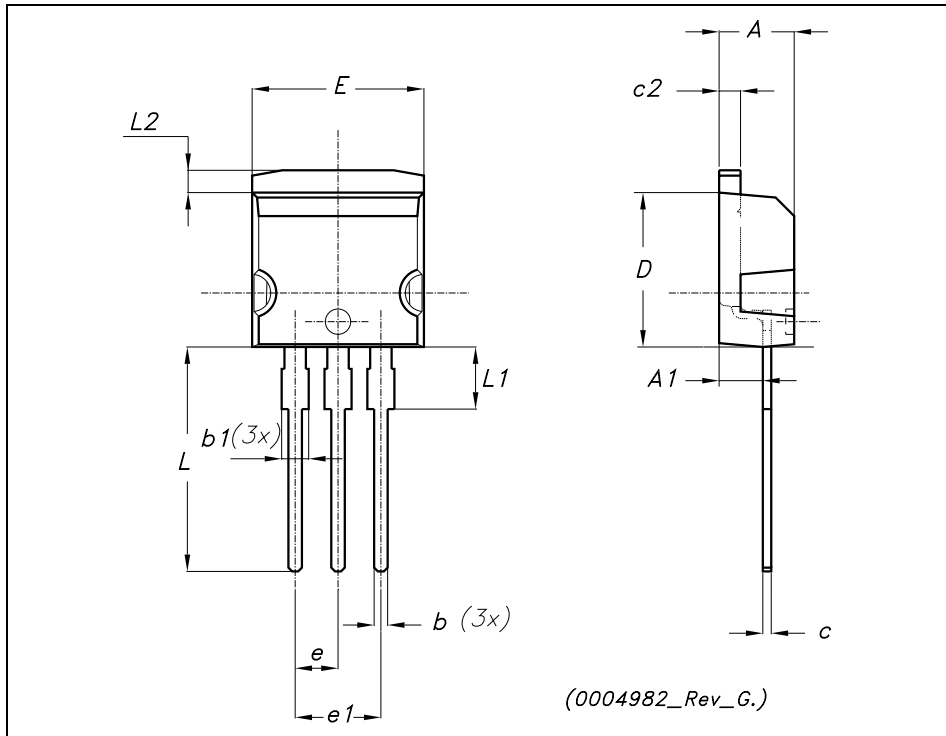
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TO-262 (I²PAK) MECHANICAL DATA

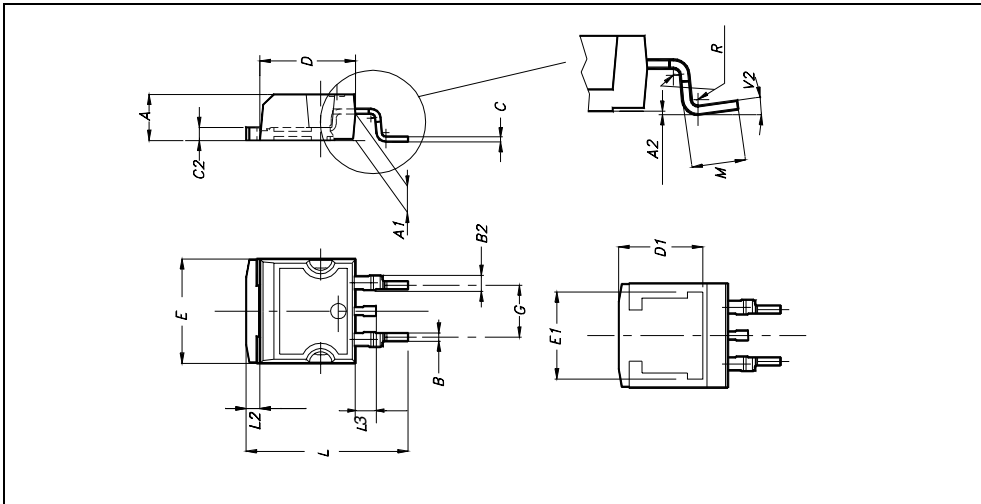
| DIM. | mm. | | | inch | | |
|------|------|------|-------|-------|------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| A1 | 2.40 | | 2.72 | 0.094 | | 0.107 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 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 |

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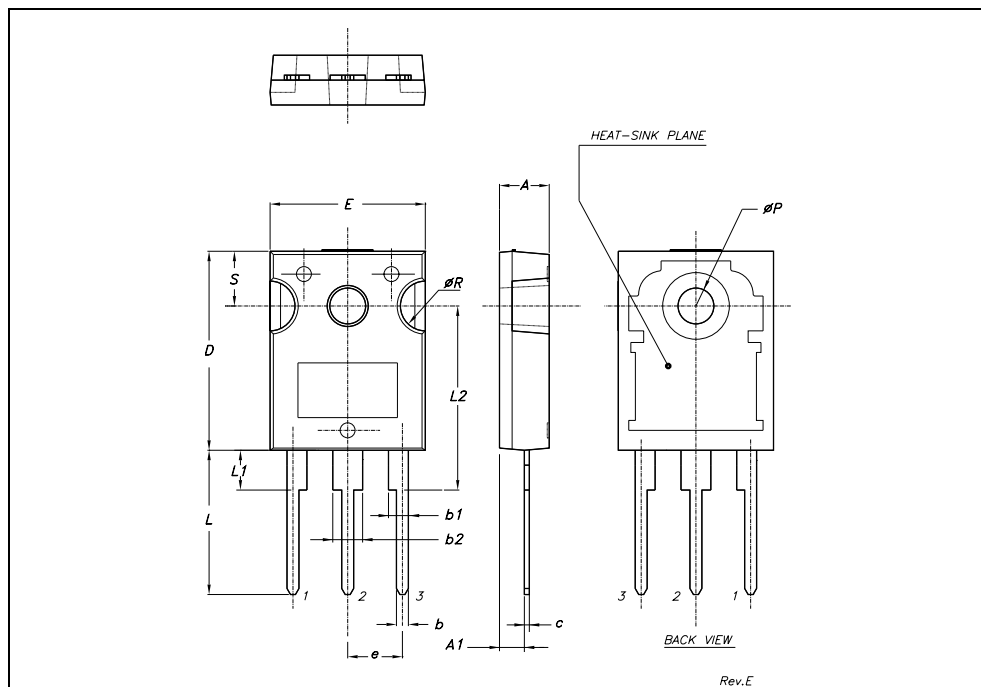
D²PAK MECHANICAL DATA

| 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 Packaging mechanical data

D²PAK FOOTPRINT



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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

TRL

FEED DIRECTION

Bending radius R min.

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 |

* on sales type

6 Revision history

Table 8. Revision history

| Date | Revision | Changes |
|-------------|----------|---------------|
| 03-May-2007 | 1 | First release |

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