



STP21NM60N-STF21NM60N-STW21NM60N STB21NM60N - STB21NM60N-1

N-CHANNEL 600V - 0.19 Ω - 17 A TO-220/FP/D²/I²PAK/TO-247
SECOND GENERATION MDmesh™ MOSFET

Table 1: General Features

| TYPE | V _{DSS} | R _{DS(on)} | I _D |
|--------------|------------------|---------------------|----------------|
| STB21NM60N | 660 V | < 0.24 Ω | 17 A |
| STB21NM60N-1 | 660 V | < 0.24 Ω | 17 A |
| STF21NM60N | 660 V | < 0.24 Ω | 17 A (*) |
| STP21NM60N | 660 V | < 0.24 Ω | 17 A |
| STW21NM60N | 660 V | < 0.24 Ω | 17 A |

- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE

DESCRIPTION

The **STx21NM60N** 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

APPLICATIONS

The MDmesh™ II family is very suitable for increasing power density of high voltage converters allowing system miniaturization and higher efficiencies.

Figure 1: Package

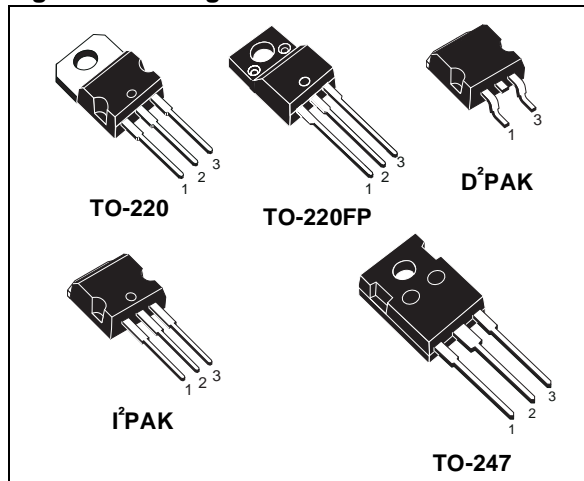


Figure 2: Internal Schematic Diagram

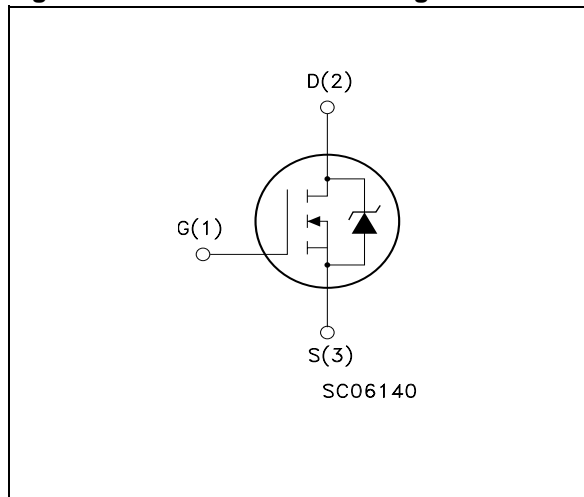


Table 2: Order Codes

| SALES TYPE | MARKING | PACKAGE | PACKAGING |
|--------------|----------|--------------------|-------------|
| STB21NM60N | B21NM60N | D ² PAK | TAPE & REEL |
| STB21NM60N-1 | B21NM60N | I ² PAK | TUBE |
| STF21NM60N | F21NM60N | TO-220FP | TUBE |
| STP21NM60N | P21NM60N | TO-220 | TUBE |
| STW21NM60N | W21NM60N | TO-247 | TUBE |

Table 3: 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) | 600 | | V |
| V _{DGR} | Drain-gate Voltage (R _{GS} = 20 kΩ) | 600 | | V |
| V _{GS} | Gate- source Voltage | ±25 | | V |
| I _D | Drain Current (continuous) at T _C = 25°C | 17 | 17 (*) | A |
| I _D | Drain Current (continuous) at T _C = 100°C | 10 | 10 (*) | A |
| I _{DM} (●) | Drain Current (pulsed) | 64 | 64 (*) | A |
| P _{TOT} | Total Dissipation at T _C = 25°C | 140 | 30 | W |
| | Derating Factor | 1.12 | 0.23 | W/°C |
| dv/dt(1) | Peak Diode Recovery voltage slope | 15 | | V/ns |
| V _{iso} | Insulation Withstand Voltage (DC) | -- | 2500 | V |
| T _{stg} | Storage Temperature | -55 to 150 150 | | °C |
| T _j | Max. Operating Junction Temperature | | | |

(●) Pulse width limited by safe operating area

(*) Limited only by maximum temperature allowed

(1) I_{SD} ≤ 16 A, di/dt ≤ 400 A/μs, V_{DD}=80% V_{(BR)DSS}

Table 4: Thermal Data

| | | TO-220 / D ² PAK / I ² PAK / TO-247 | TO-220FP | |
|-----------------------|--|---|----------|------|
| 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 5: Avalanche Characteristics

| Symbol | Parameter | Max Value | Unit |
|-----------------|--|-----------|------|
| I _{AS} | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T _j max) | 8.5 | A |
| E _{AS} | Single Pulse Avalanche Energy (starting T _j = 25 °C, I _D = I _{AS} , V _{DD} = 50 V) | 610 | mJ |

ELECTRICAL CHARACTERISTICS ($T_{CASE} = 25^{\circ}C$ UNLESS OTHERWISE SPECIFIED)

Table 6: On/Off

| Symbol | Parameter | Test Conditions | Value | | | Unit |
|---------------|--|--|-------|-------|---------|--------------------|
| | | | Min. | Typ. | Max. | |
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage | $I_D = 1mA, V_{GS} = 0$ | 600 | | | V |
| $dv/dt(2)$ | Drain Source Voltage Slope | $V_{DD}=480V, I_D=17A, V_{GS}=10V$ | 48 | | | 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 | $V_{GS} = 10V, I_D = 8.5 A$ | | 0.190 | 0.24 | Ω |

(2) Characteristic value at turn off on inductive load

Table 7: Dynamic

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|--|------|----------------------|------|----------------------|
| $g_{fs} (1)$ | Forward Transconductance | $V_{DS} = 15 V, I_D = 8 A$ | | 12 | | S |
| C_{iss} C_{oss} C_{rss} | Input Capacitance Output Capacitance Reverse Transfer Capacitance | $V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$ | | 1950 508 38.4 | | pF pF pF |
| $C_{oss \text{ eq.}} (*)$ | Equivalent Output Capacitance | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 400V$ | | 282 | | pF |
| $t_{d(on)}$ t_r $t_{d(off)}$ t_f | Turn-on Delay Time Rise Time Off-voltage Rise Time Fall Time | $V_{DD} = 300 V, I_D = 8.5 A$ $R_G = 4.7\Omega, V_{GS} = 10 V$ (see Figure 20) | | 22 15 84 31 | | ns ns ns ns |
| Q_g Q_{gs} Q_{gd} | Total Gate Charge Gate-Source Charge Gate-Drain Charge | $V_{DD} = 480V, I_D = 17 A,$ $V_{GS} = 10V,$ (see Figure 23) | | 66.6 9.9 33 | | nC nC nC |
| R_g | Gate Input Resistance | $f=1\text{MHz}$ Gate DC Bias=0 Test Signal Level=20mV Open Drain | | 2 | | Ω |

(*) $C_{oss \text{ eq.}}$ 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 8: Source Drain Diode

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|--|--|------|------------------|----------|--------------------|
| I_{SD} I_{SDM} | Source-drain Current Source-drain Current (pulsed) | | | | 16 64 | A A |
| $V_{SD} (1)$ | Forward On Voltage | $I_{SD} = 17 A, V_{GS} = 0$ | | | 1.3 | V |
| t_{rr} Q_{rr} I_{RRM} | Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current | $I_{SD} = 17 A, di/dt = 100 A/\mu s$ $V_{DD} = 100 V, T_j = 25^{\circ}C$ (see Figure 21) | | 372 4.6 25 | | ns μC A |
| t_{rr} Q_{rr} I_{RRM} | Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current | $I_{SD} = 17A, di/dt = 100 A/\mu s$ $V_{DD} = 100 V, T_j = 150^{\circ}C$ (see Figure 21) | | 486 6.3 26 | | ns μC A |

Note: 1. Pulsed: Pulse duration = 300 μs , duty cycle 1.5 %.

Figure 3: Safe Operating Area For TO-220/ I²PAK/D²PAK

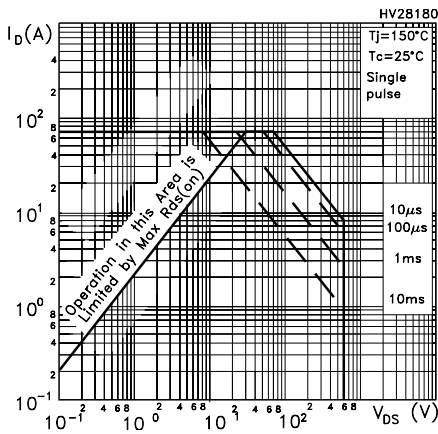


Figure 4: Safe Operating Area For TO-220FP

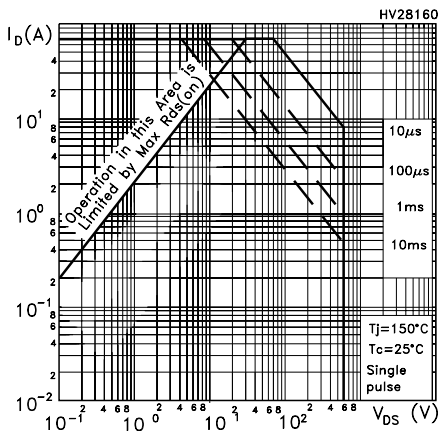


Figure 5: Safe Operating Area For TO-247

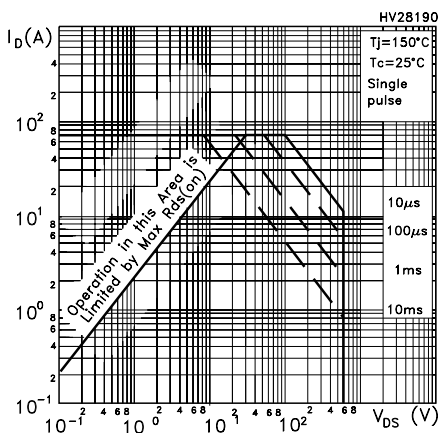


Figure 6: Thermal Impedance TO-220/I²PAK/ D²PAK

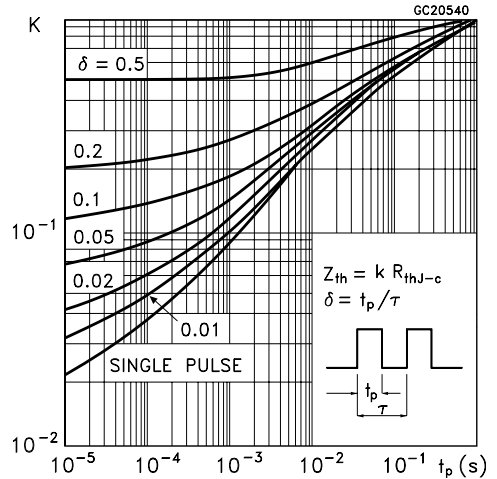


Figure 7: Thermal Impedance For TO-220FP

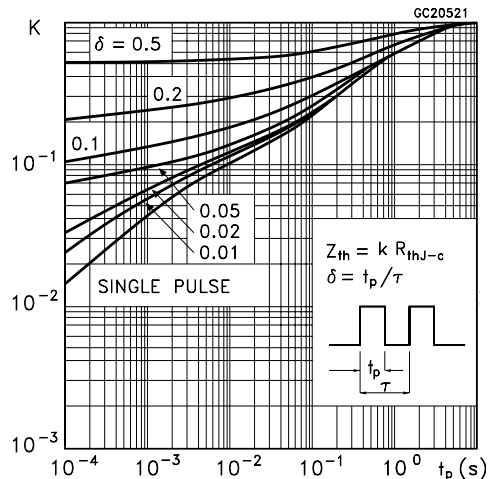


Figure 8: Thermal Impedance For TO-247

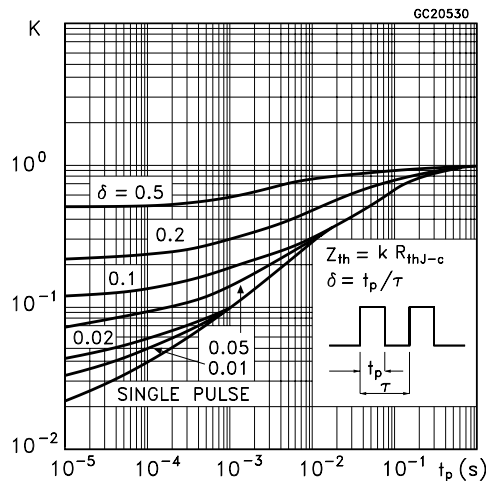


Figure 9: Output Characteristics
Output Characteristics

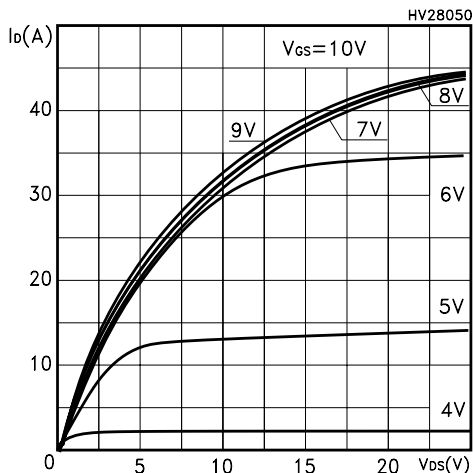


Figure 10: Transconductance

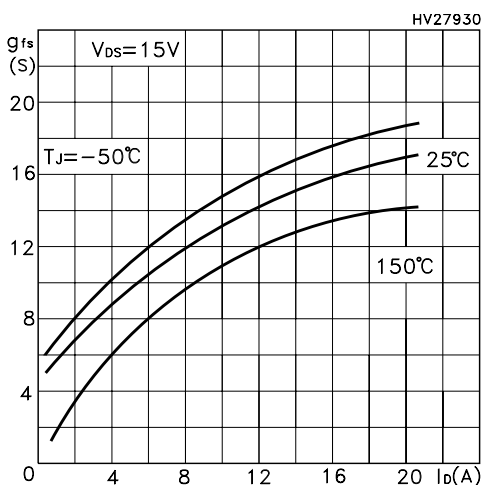


Figure 11: Gate Charge vs Gate-source Voltage

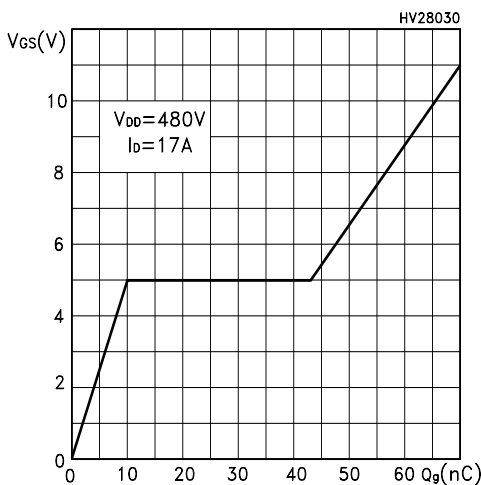


Figure 12: Transfer Characteristics

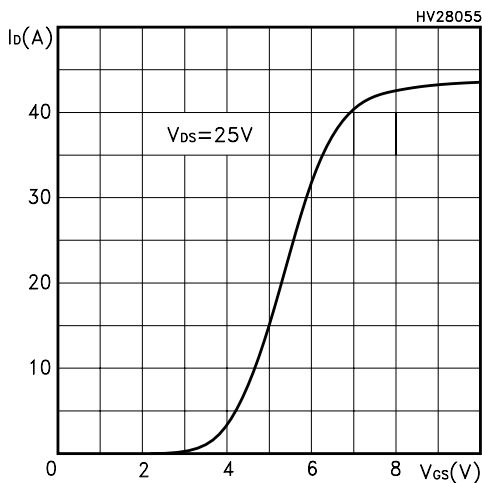


Figure 13: Static Drain-Source On Resistance

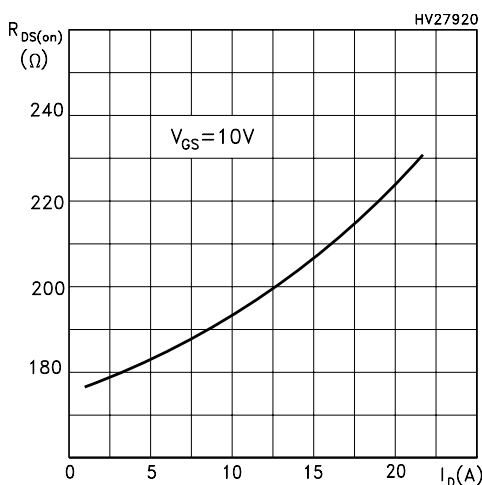


Figure 14: Capacitance Variations

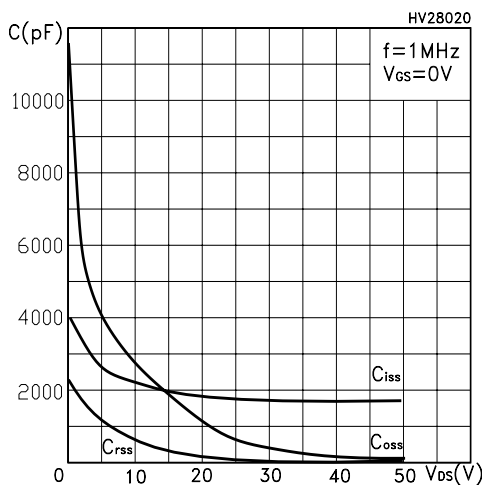


Figure 15: Normalized Gate Threshold Voltage vs Temperature

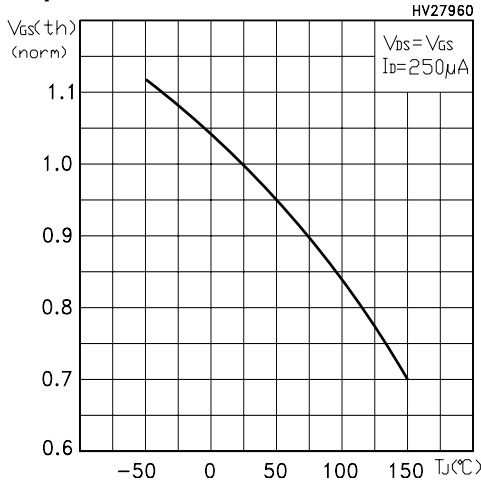


Figure 16: Source-Drain Forward Characteristics

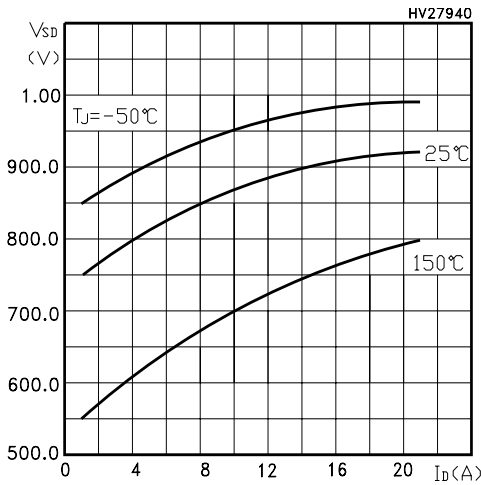


Figure 17: Normalized On Resistance vs Temperature

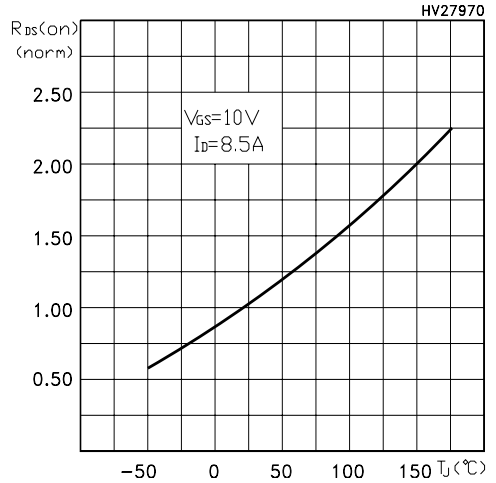


Figure 18: Normalized BV_{DSS} vs Temperature

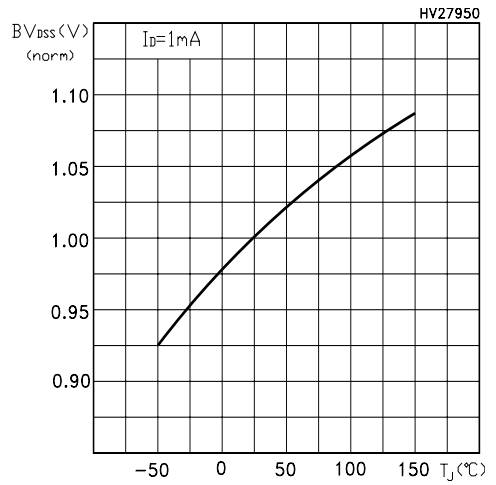


Figure 19: Unclamped Inductive Load Test Circuit

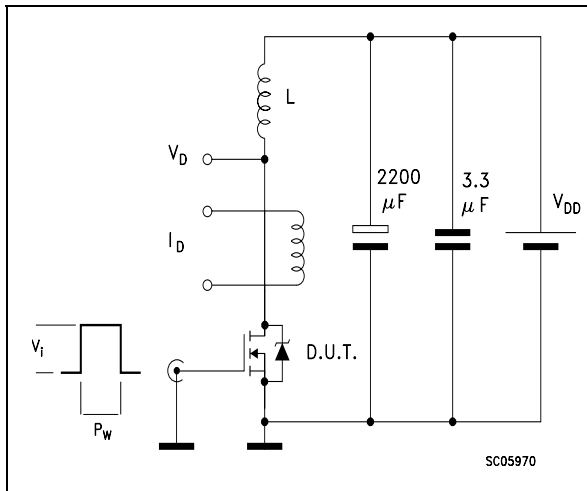


Figure 20: Switching Times Test Circuit For Resistive Load

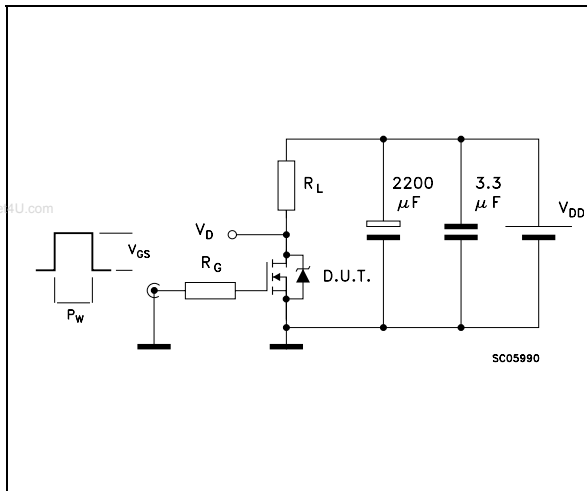


Figure 21: Test Circuit For Inductive Load Switching and Diode Recovery Times

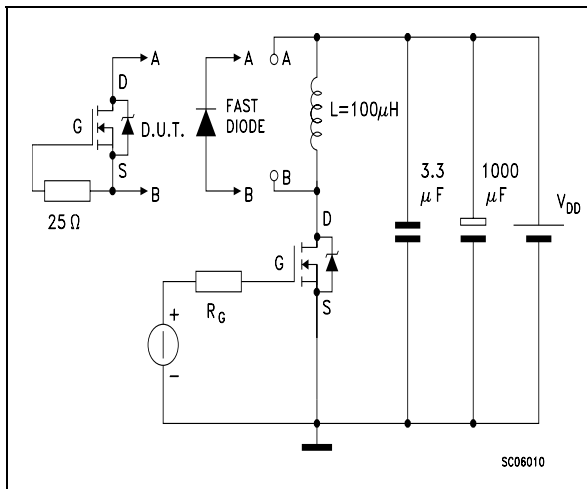


Figure 22: Unclamped Inductive Waferform

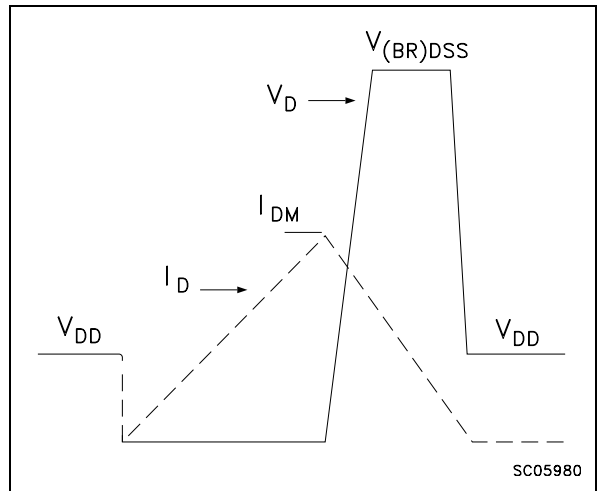
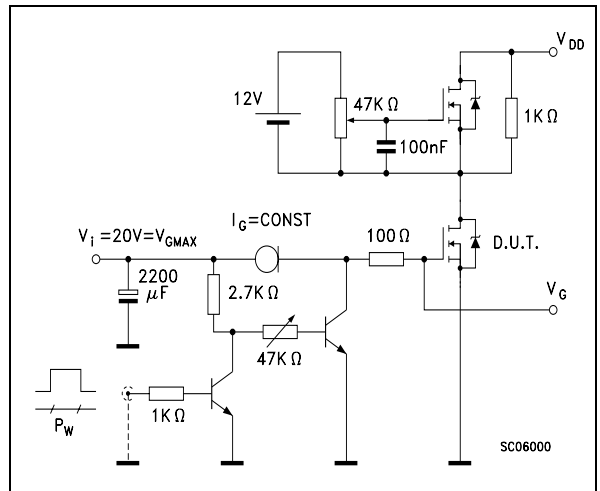


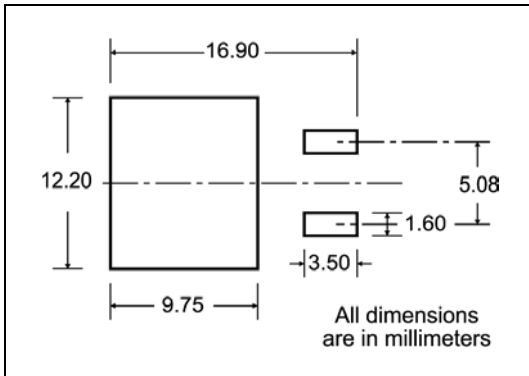
Figure 23: Gate Charge Test Circuit



STP21NM60N - STF21NM60N - STB21NM60N - STB21NM60N-1 - STW21NM60N

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

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 |

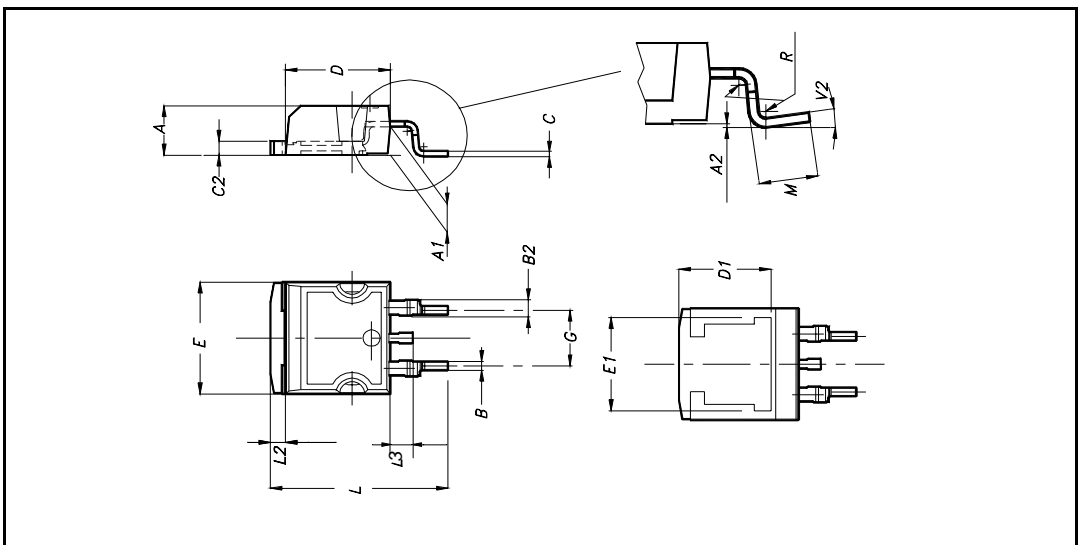
| BASE QTY | BULK QTY |
|----------|----------|
| 1000 | 1000 |

* on sales type

D²PAK MECHANICAL DATA

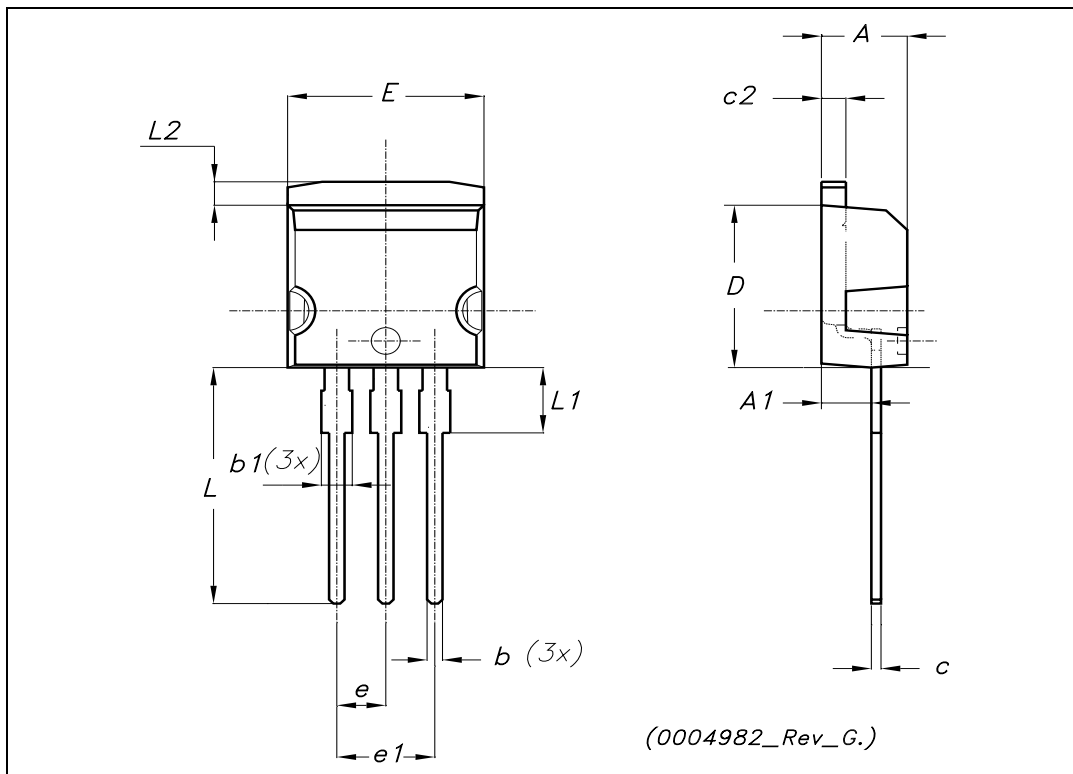
| DIM. | mm. | | | inch | | |
|------|------|------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 4.6 | 0.173 | | 0.181 |
| A1 | 2.49 | | 2.69 | 0.098 | | 0.106 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.7 | | 0.93 | 0.027 | | 0.036 |
| B2 | 1.14 | | 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° | | | |

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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 |

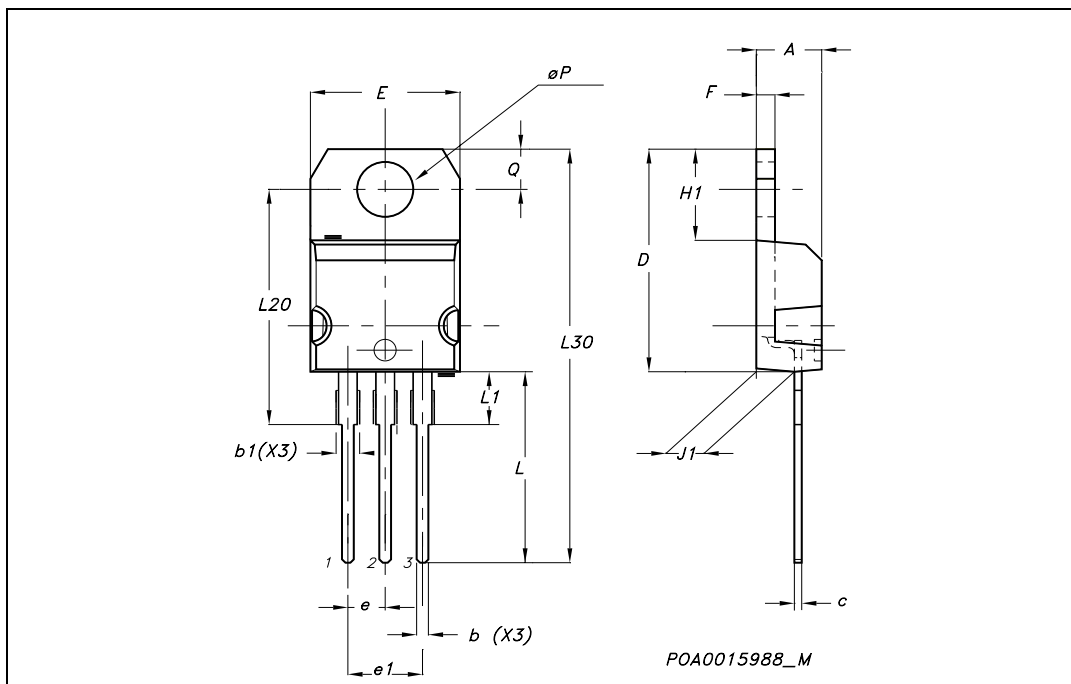


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TO-220 MECHANICAL DATA

| 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 |

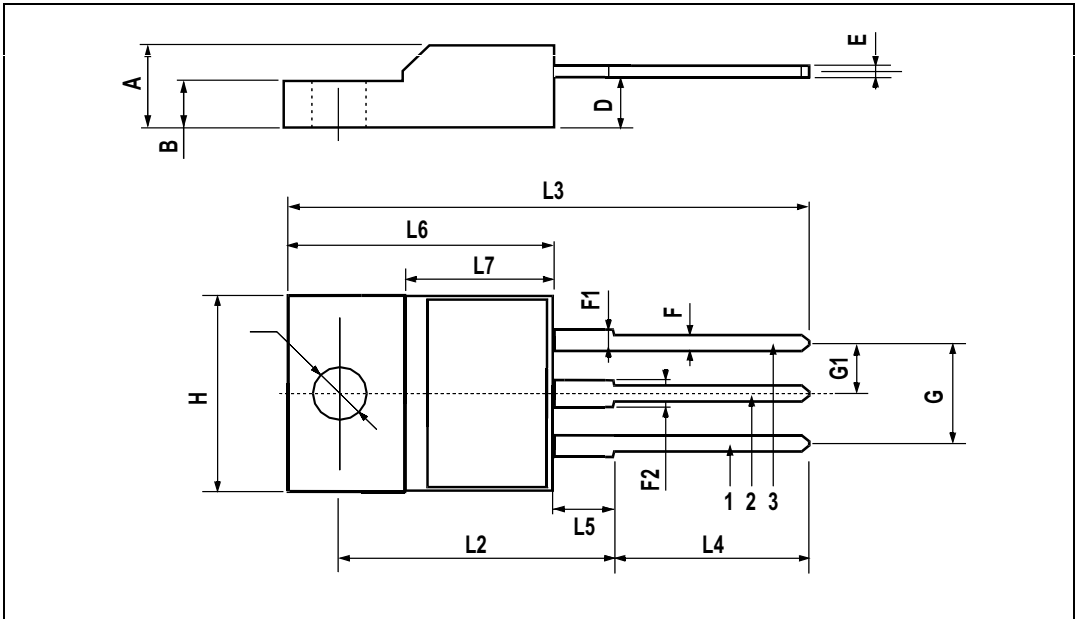
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TO-220FP MECHANICAL DATA

| 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 |
| ∅ | 3 | | 3.2 | 0.118 | | 0.126 |

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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 | |

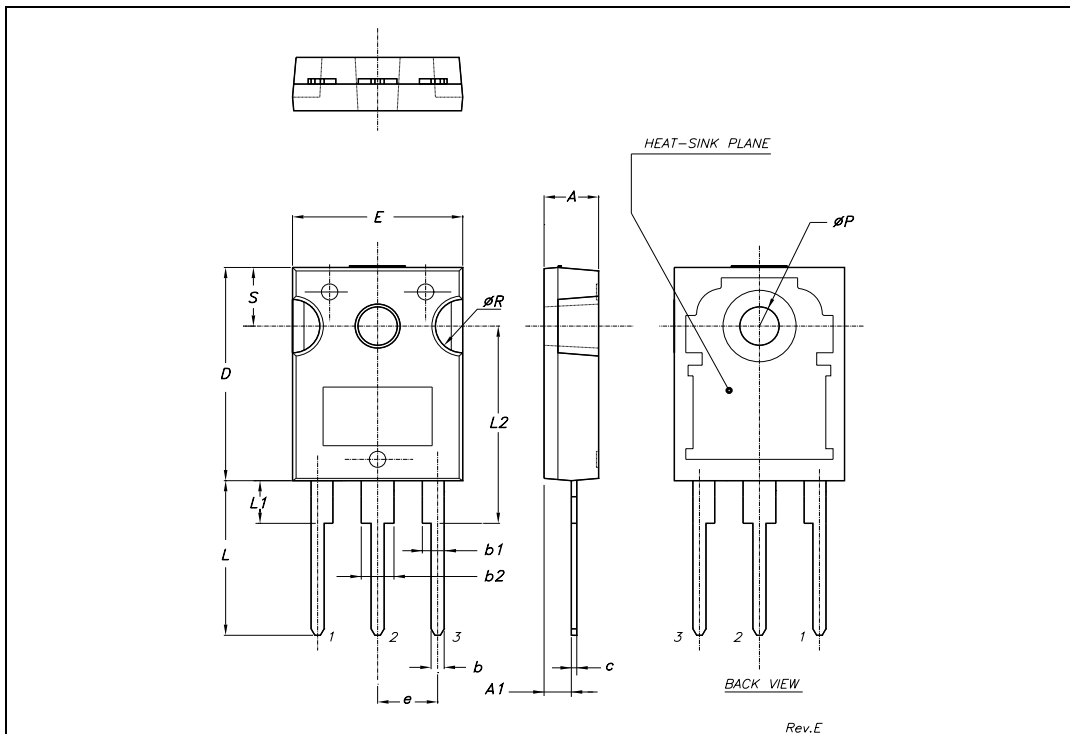


Table 9: Revision History

| Date | Revision | Description of Changes |
|-------------|-----------------|-------------------------------|
| 22-Sep-2005 | 1 | First Release. |
| 05-Oct-2005 | 2 | Modified curves 9-12 |
| 26-Oct-2005 | 3 | Complete version |

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