



# STP21NM50N-STF21NM50N-STW21NM50N STB21NM50N - STB21NM50N-1

N-CHANNEL 500V - 0.15Ω - 18A TO-220/FP/D<sup>2</sup>/I<sup>2</sup>PAK/TO-247  
SECOND GENERATION MDmesh™ MOSFET

**Table 1: General Features**

| TYPE         | V <sub>DSS</sub><br>(@T <sub>jmax</sub> ) | R <sub>DS(on)</sub> | I <sub>D</sub> |
|--------------|-------------------------------------------|---------------------|----------------|
| STB21NM50N   | 550 V                                     | < 0.19 Ω            | 18 A           |
| STB21NM50N-1 | 550 V                                     | < 0.19 Ω            | 18 A           |
| STF21NM50N   | 550 V                                     | < 0.19 Ω            | 18 A (*)       |
| STP21NM50N   | 550 V                                     | < 0.19 Ω            | 18 A           |
| STW21NM50N   | 550 V                                     | < 0.19 Ω            | 18 A           |

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

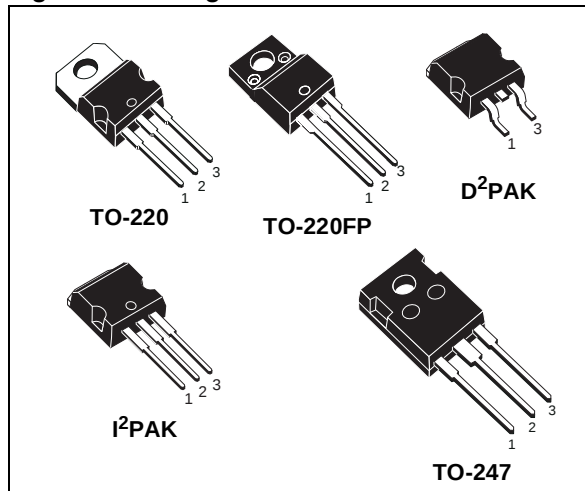
## DESCRIPTION

The **STx21NM50N** 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

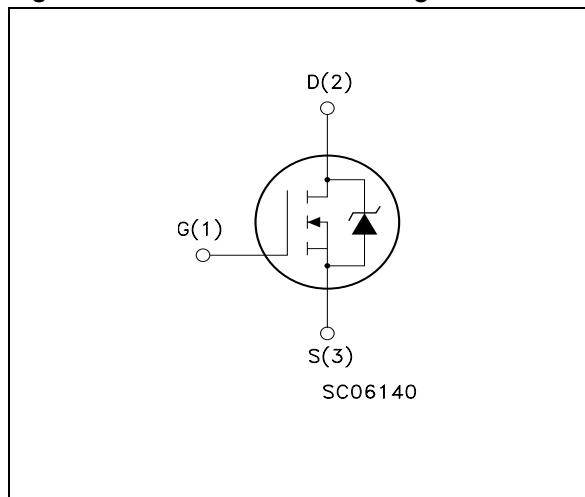
## APPLICATIONS

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   |
|--------------|----------|--------------------|-------------|
| STB21NM50N   | B21NM50N | D <sup>2</sup> PAK | TAPE & REEL |
| STB21NM50N-1 | B21NM50N | I <sup>2</sup> PAK | TUBE        |
| STF21NM50N   | F21NM50N | TO-220FP           | TUBE        |
| STP21NM50N   | P21NM50N | TO-220             | TUBE        |
| STW21NM50N   | W21NM50N | TO-247             | TUBE        |

Table 3: Absolute Maximum ratings

| Symbol              | Parameter                                            | Value                                                     |          | Unit |
|---------------------|------------------------------------------------------|-----------------------------------------------------------|----------|------|
|                     |                                                      | TO-220 / D <sup>2</sup> PAK / I <sup>2</sup> PAK / TO-247 | TO-220FP |      |
| V <sub>DS</sub>     | Drain-source Voltage (V <sub>GS</sub> = 0)           | 500                                                       |          | V    |
| V <sub>DGR</sub>    | Drain-gate Voltage (R <sub>GS</sub> = 20 kΩ)         | 500                                                       |          | V    |
| V <sub>GS</sub>     | Gate- source Voltage                                 | ±25                                                       |          | V    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>C</sub> = 25°C  | 18                                                        | 18 (*)   | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>C</sub> = 100°C | 11                                                        | 11 (*)   | A    |
| I <sub>DM</sub> (●) | Drain Current (pulsed)                               | 72                                                        | 72 (*)   | A    |
| P <sub>TOT</sub>    | Total Dissipation at T <sub>C</sub> = 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 <sub>ISO</sub>    | Insulation Withstand Voltage (DC)                    | --                                                        | 2500     | V    |
| T <sub>stg</sub>    | Storage Temperature                                  | -55 to 150<br>150                                         |          | °C   |
| T <sub>j</sub>      | Max. Operating Junction Temperature                  |                                                           |          |      |

(●) Pulse width limited by safe operating area

(\*) Limited only by maximum temperature allowed

(1) I<sub>SD</sub> ≤ 18 A, di/dt ≤ 400 A/μs, V<sub>DD</sub> = 80% V(BR)<sub>DSS</sub>

Table 4: Thermal Data

|                       |                                                | TO-220 / D <sup>2</sup> PAK / I <sup>2</sup> PAK / TO-247 | TO-220FP |      |
|-----------------------|------------------------------------------------|-----------------------------------------------------------|----------|------|
| R <sub>thj-case</sub> | Thermal Resistance Junction-case Max           | 0.89                                                      | 4.21     | °C/W |
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient Max        | 62.5                                                      |          | °C/W |
| T <sub>I</sub>        | Maximum Lead Temperature For Soldering Purpose | 300                                                       |          | °C   |

Table 5: Avalanche Characteristics

| Symbol          | Parameter                                                                                                                  | Max Value | Unit |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|-----------|------|
| I <sub>AS</sub> | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>j</sub> max)                                | 9         | A    |
| E <sub>AS</sub> | Single Pulse Avalanche Energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 480       | mJ   |

**ELECTRICAL CHARACTERISTICS** ( $T_{CASE} = 25^{\circ}\text{C}$  UNLESS OTHERWISE SPECIFIED)**Table 6: On/Off**

| Symbol        | Parameter                                        | Test Conditions                                                                             | Value |       |         | Unit                           |
|---------------|--------------------------------------------------|---------------------------------------------------------------------------------------------|-------|-------|---------|--------------------------------|
|               |                                                  |                                                                                             | Min.  | Typ.  | Max.    |                                |
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage                   | $I_D = 1\text{mA}$ , $V_{GS} = 0$                                                           | 500   |       |         | V                              |
| $dv/dt(2)$    | Drain Source Voltage Slope                       | $V_{DD}=400\text{V}$ , $I_D=25\text{A}$ , $V_{GS}=10\text{V}$                               | 44    |       |         | V/ns                           |
| $I_{DSS}$     | Zero Gate Voltage Drain Current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating}$<br>$T_C = 125^{\circ}\text{C}$ |       |       | 1<br>10 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body Leakage Current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{V}$                                                                   |       |       | 100     | nA                             |
| $V_{GS(th)}$  | Gate Threshold Voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$                                                | 2     | 3     | 4       | V                              |
| $R_{DS(on)}$  | Static Drain-source On Resistance                | $V_{GS} = 10\text{V}$ , $I_D = 9\ \text{A}$                                                 |       | 0.150 | 0.190   | $\Omega$                       |

(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                                                | $V_{DS} = 15\ \text{V}$ , $I_D = 9\ \text{A}$                                                                  |      | 12                   |      | S                    |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$           | Input Capacitance<br>Output Capacitance<br>Reverse Transfer Capacitance | $V_{DS} = 25\text{V}$ , $f = 1\ \text{MHz}$ , $V_{GS} = 0$                                                     |      | 1950<br>420<br>60    |      | pF<br>pF<br>pF       |
| $C_{oss\ eq. (*)}$                            | Equivalent Output Capacitance                                           | $V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V to } 400\text{V}$                                                    |      | 270                  |      | pF                   |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on Delay Time<br>Rise Time<br>Off-voltageRise Time<br>Fall Time    | $V_{DD} = 250\ \text{V}$ , $I_D = 9\ \text{A}$<br>$R_G = 4.7\Omega$ $V_{GS} = 10\ \text{V}$<br>(see Figure 18) |      | 22<br>18<br>90<br>30 |      | ns<br>ns<br>ns<br>ns |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$                 | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge            | $V_{DD} = 400\text{V}$ , $I_D = 18\ \text{A}$ ,<br>$V_{GS} = 10\text{V}$ ,<br>(see Figure 21)                  |      | 65<br>10<br>30       |      | nC<br>nC<br>nC       |
| $R_g$                                         | Gate Input Resistance                                                   | $f=1\text{MHz}$ Gate DC Bias=0<br>Test Signal Level=20mV<br>Open Drain                                         |      | 1.6                  |      | $\Omega$             |

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

| Symbol                            | Parameter                                                                    | Test Conditions                                                                                                                           | Min. | Typ.             | Max.     | Unit                     |
|-----------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------|------------------|----------|--------------------------|
| $I_{SD}$<br>$I_{SDM}$             | Source-drain Current<br>Source-drain Current (pulsed)                        |                                                                                                                                           |      |                  | 18<br>72 | A<br>A                   |
| $V_{SD} (1)$                      | Forward On Voltage                                                           | $I_{SD} = 18\ \text{A}$ , $V_{GS} = 0$                                                                                                    |      |                  | 1.5      | V                        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD} = 18\ \text{A}$ , $di/dt = 100\ \text{A}/\mu\text{s}$<br>$V_{DD} = 100\ \text{V}$ , $T_j = 25^{\circ}\text{C}$<br>(see Figure 19) |      | 360<br>5<br>27   |          | ns<br>$\mu\text{C}$<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD} = 18\text{A}$ , $di/dt = 100\ \text{A}/\mu\text{s}$<br>$V_{DD} = 100\ \text{V}$ , $T_j = 150^{\circ}\text{C}$<br>(see Figure 19)  |      | 640<br>6.5<br>27 |          | ns<br>$\mu\text{C}$<br>A |

Note: 1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

Figure 3: Safe Operating Area For TO-220

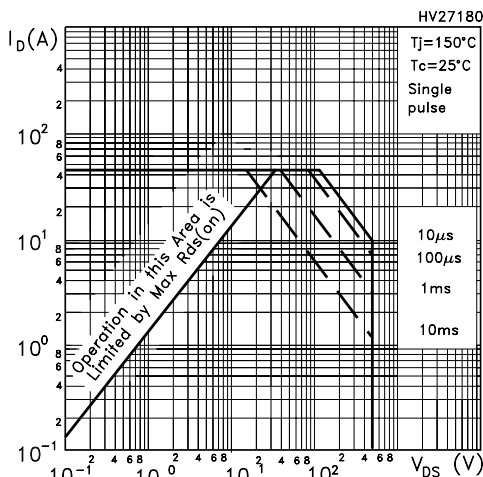


Figure 4: Safe Operating Area For TO-220FP

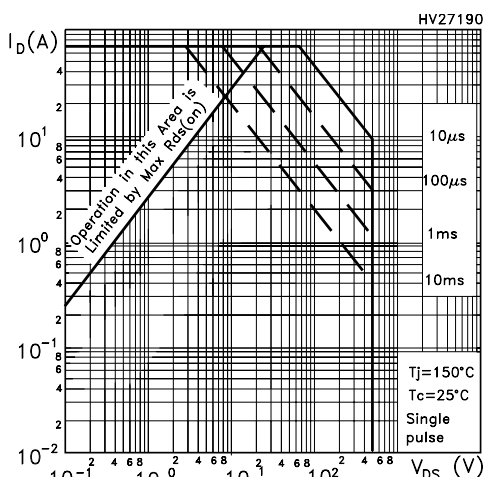


Figure 5: Output Characteristics

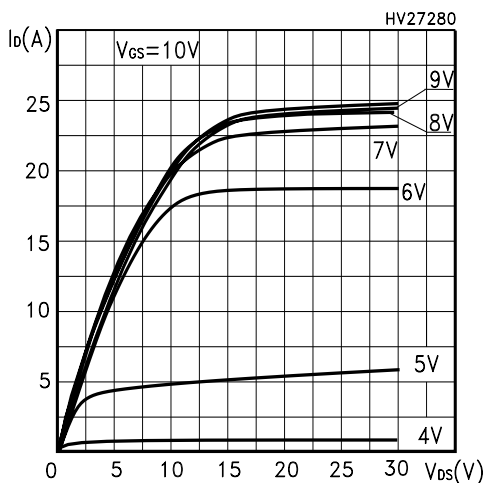


Figure 6: Thermal Impedance For TO-220

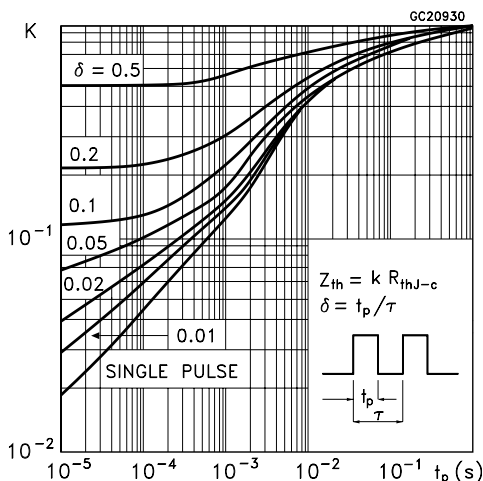


Figure 7: Thermal Impedance For TO-220FP

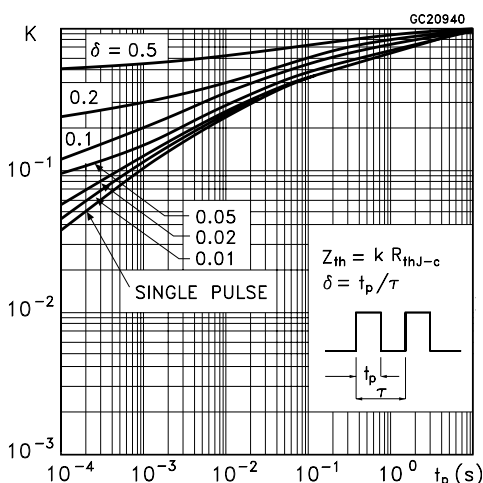


Figure 8: Transfer Characteristics

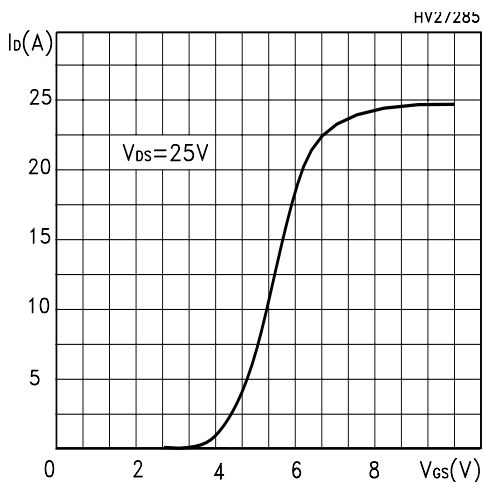


Figure 9: Transconductance

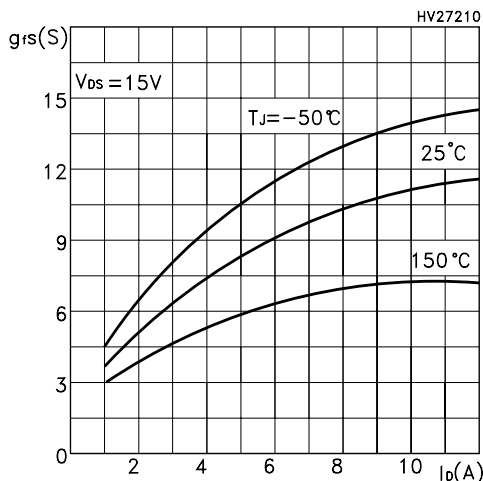


Figure 10: Gate Charge vs Gate-source Voltage

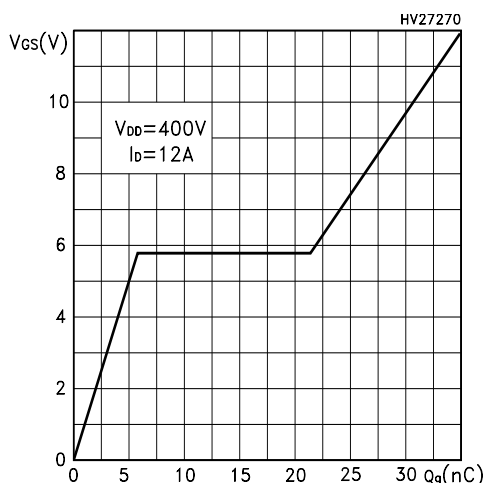


Figure 11: Normalized Gate Threshold Voltage vs Temperature

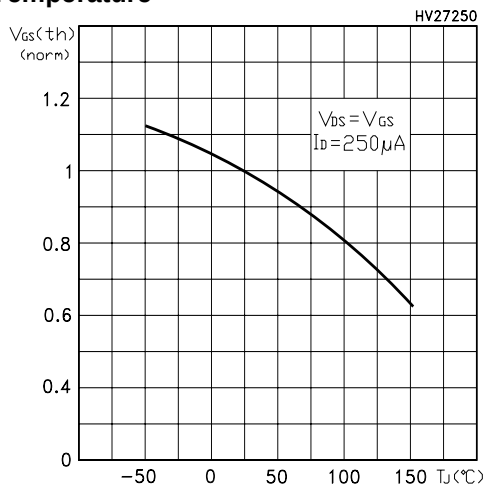


Figure 12: Static Drain-source On Resistance

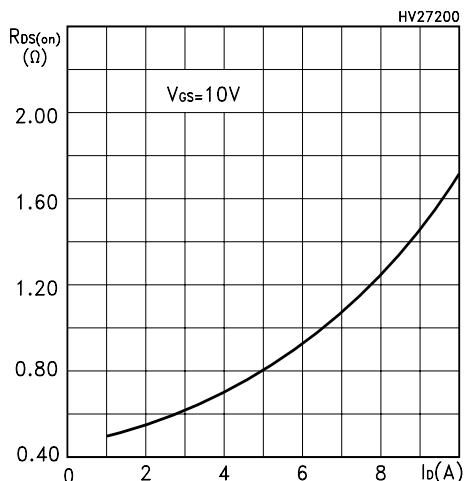


Figure 13: Capacitance Variations

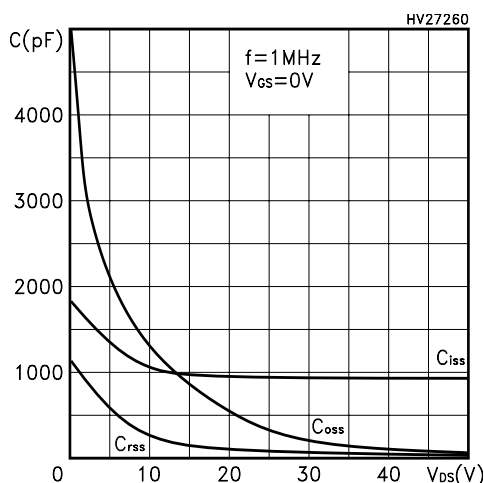


Figure 14: Normalized On Resistance vs Temperature

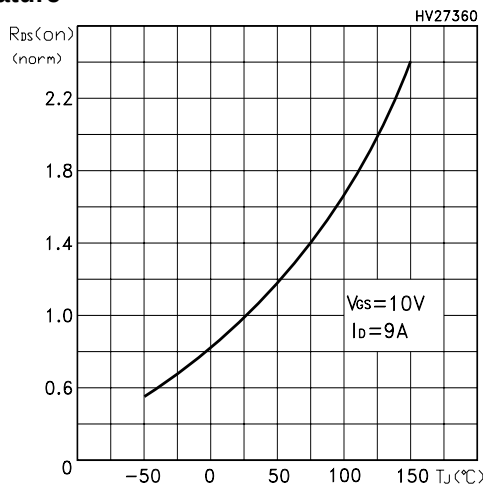


Figure 15: Source-Drain Forward Characteristics

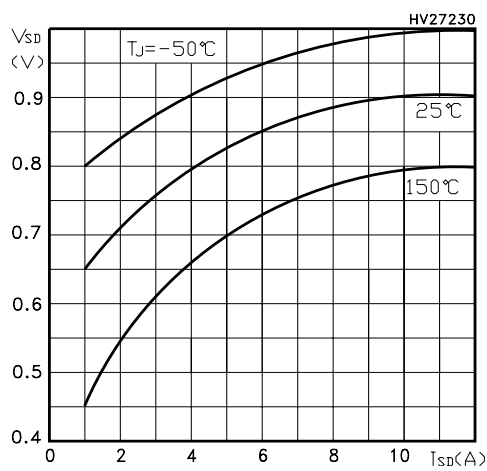
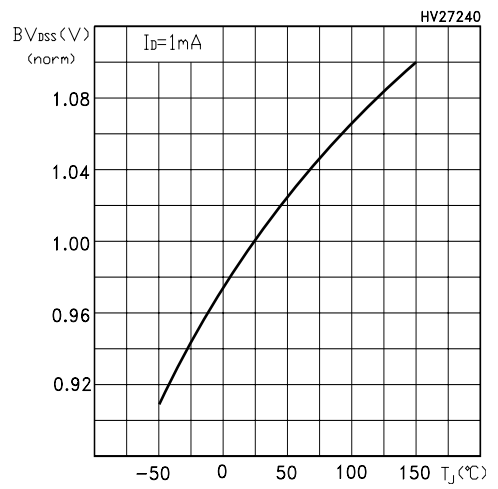
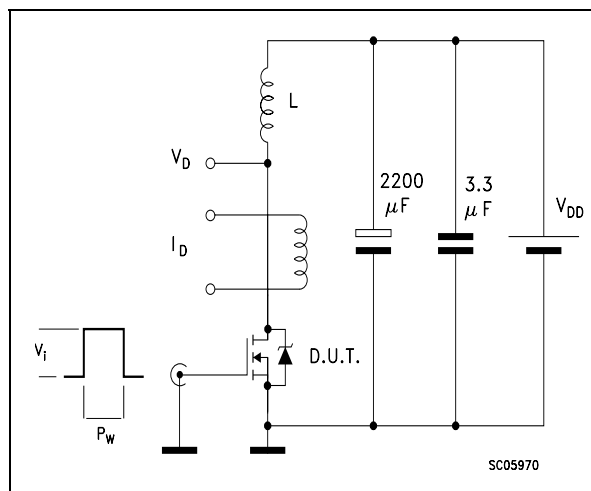


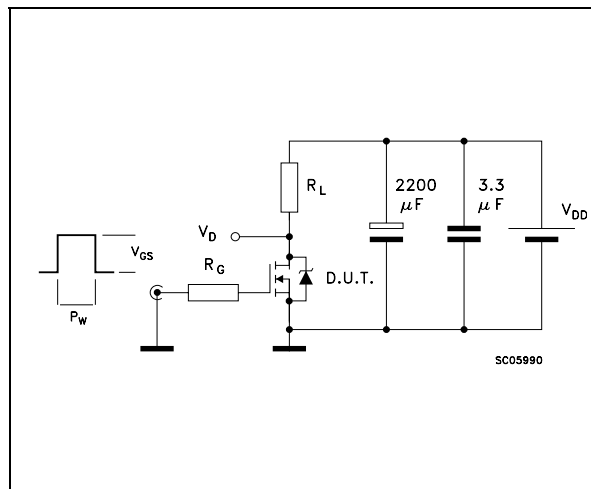
Figure 16: Normalized  $BV_{DSS}$  vs Temperature



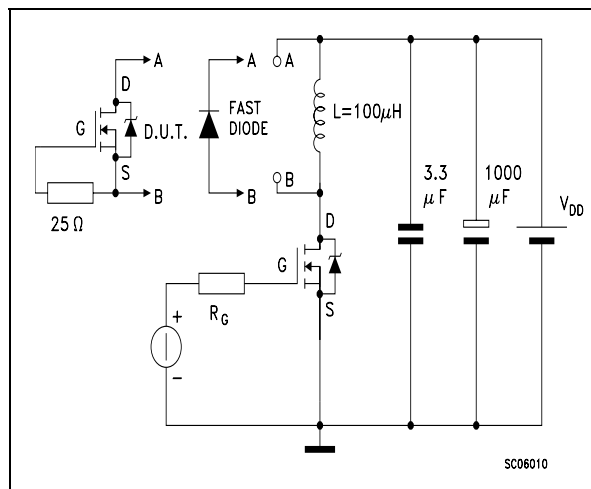
**Figure 17: Unclamped Inductive Load Test Circuit**



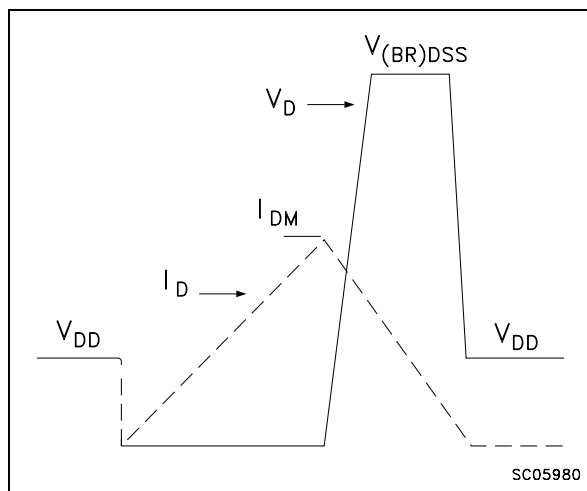
**Figure 18: Switching Times Test Circuit For Resistive Load**



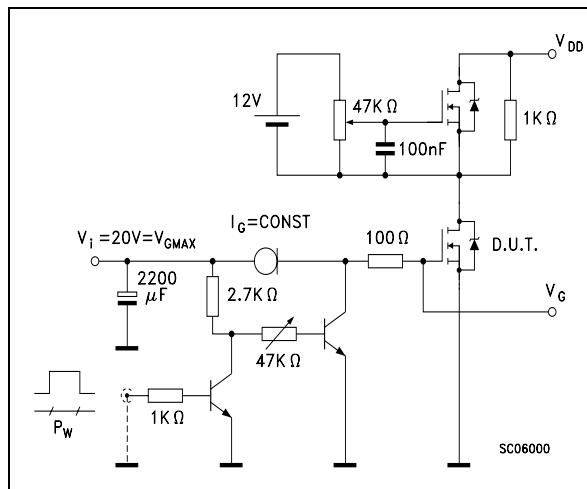
**Figure 19: Test Circuit For Inductive Load Switching and Diode Recovery Times**



**Figure 20: Unclamped Inductive Waeform**

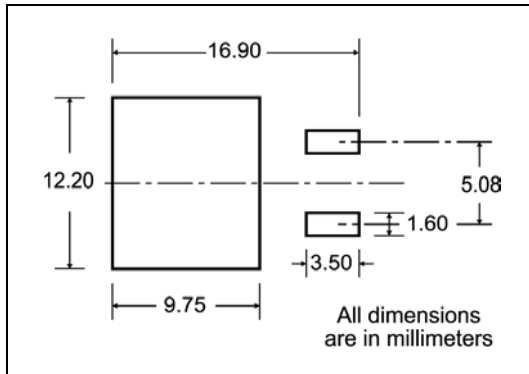


**Figure 21: Gate Charge Test Circuit**

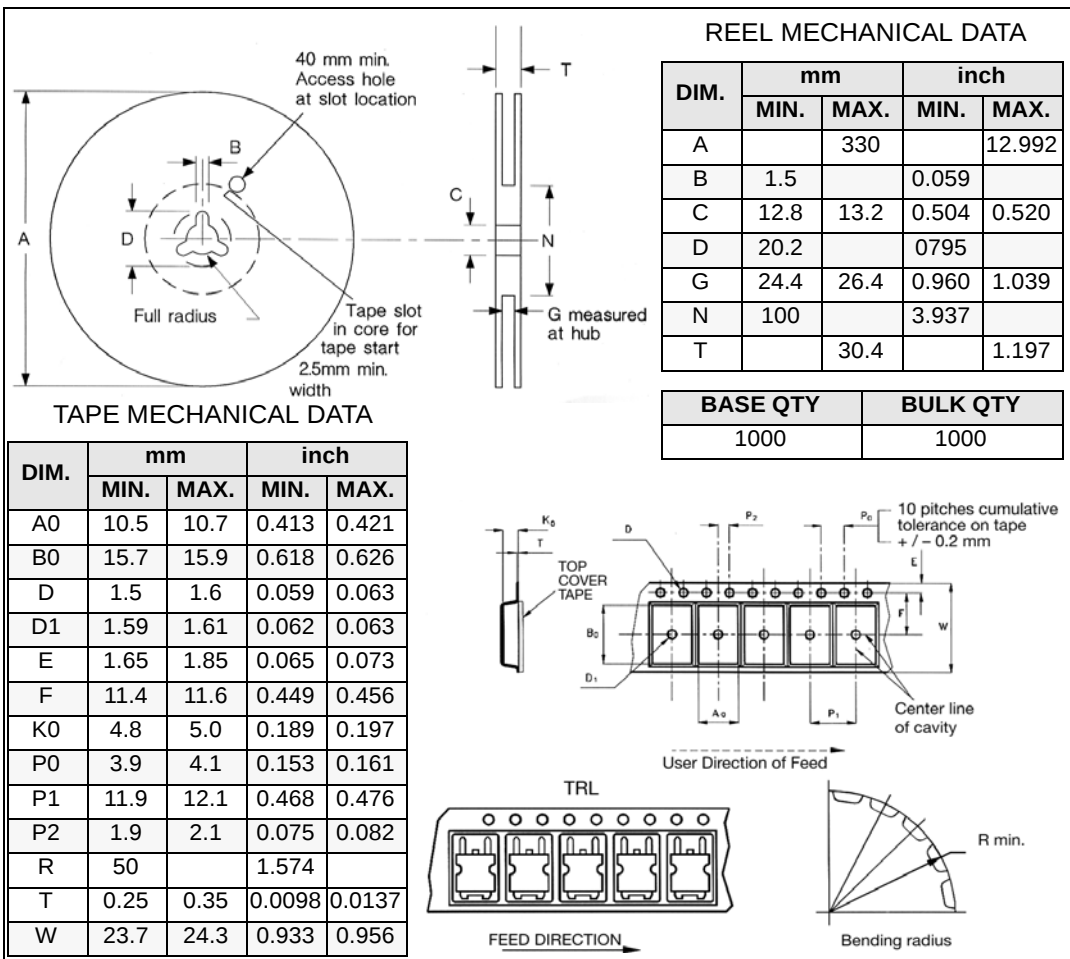


In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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](http://www.st.com)

## D<sup>2</sup>PAK FOOTPRINT



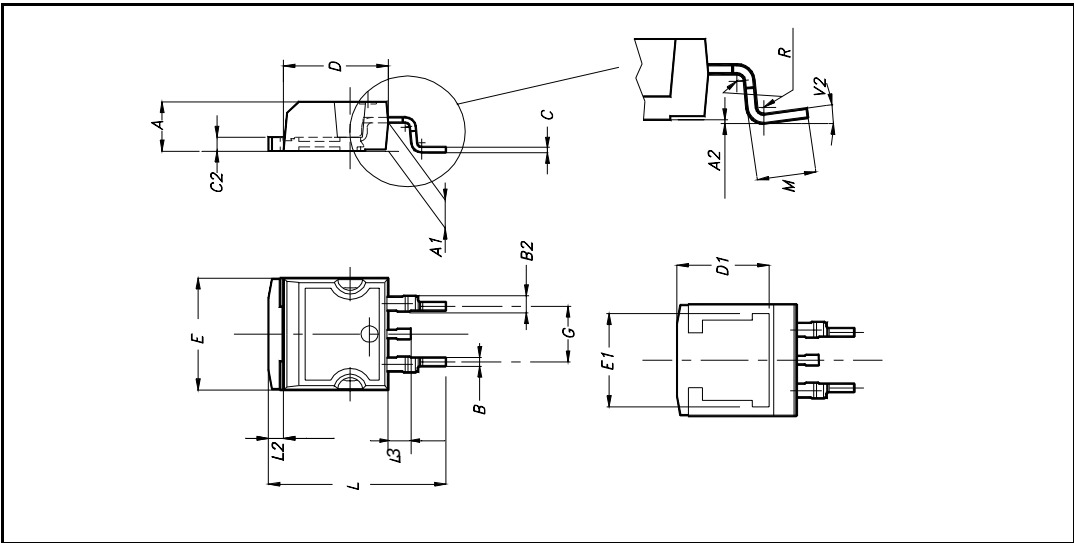
## TAPE AND REEL SHIPMENT



\* on sales type

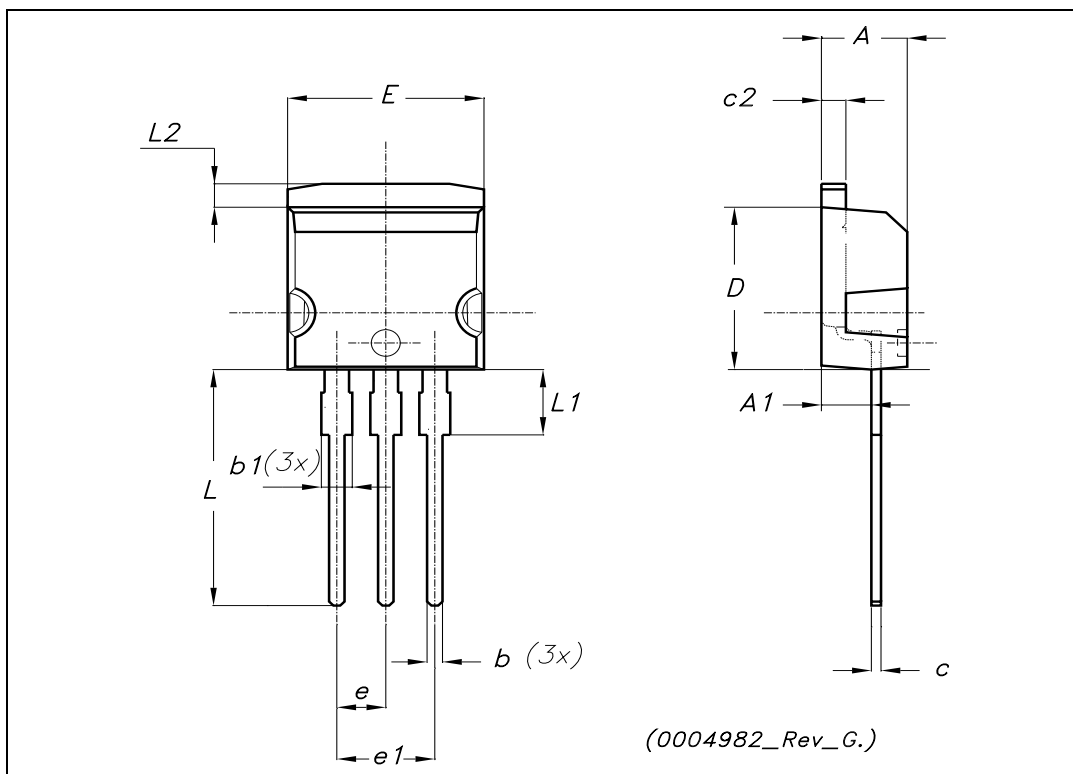
D<sup>2</sup>PAK MECHANICAL DATA

| 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°    |       |       |       |



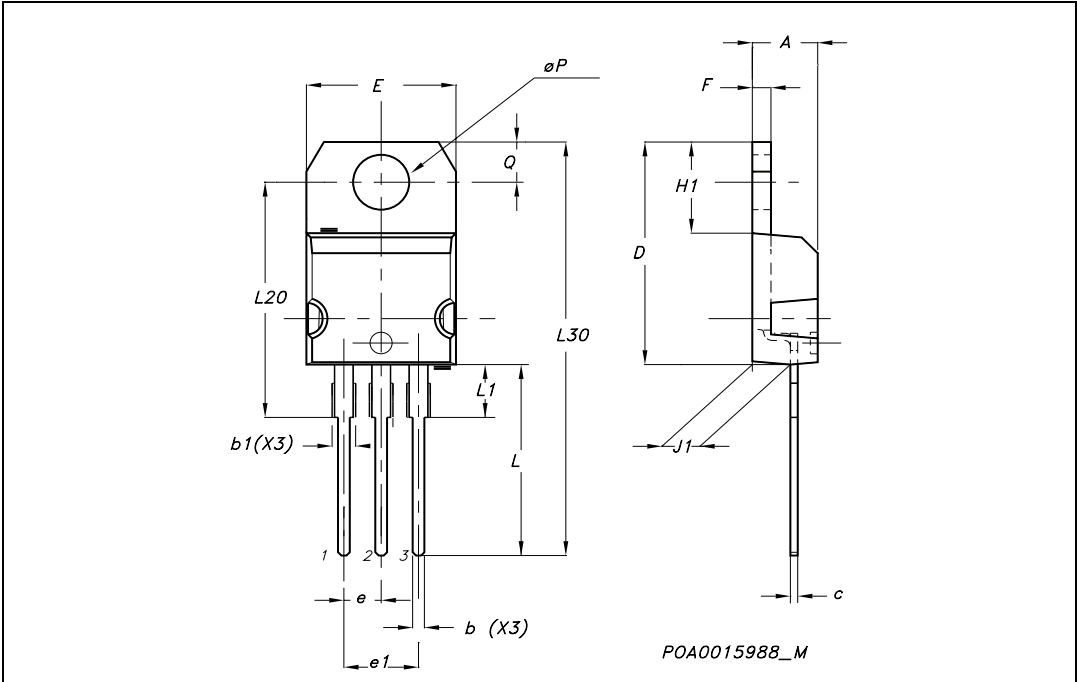
TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA

| 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 |



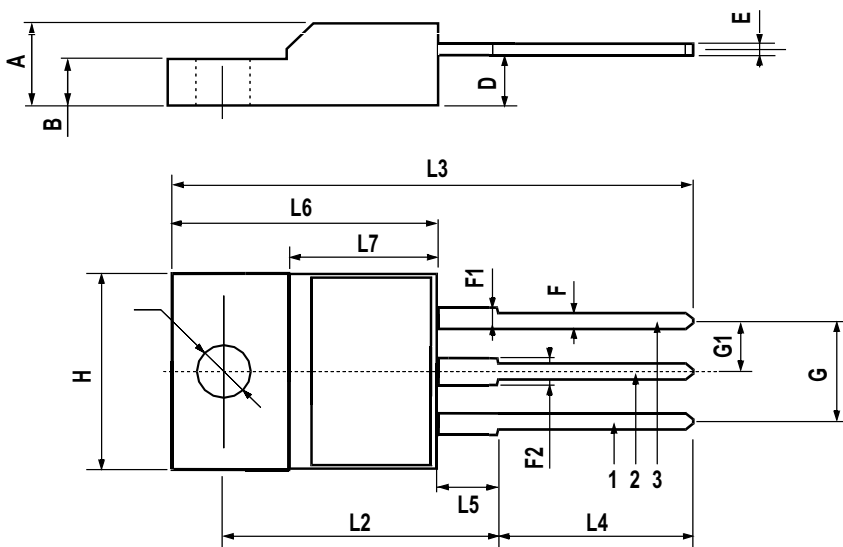
TO-220 MECHANICAL DATA

| 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-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 |       |

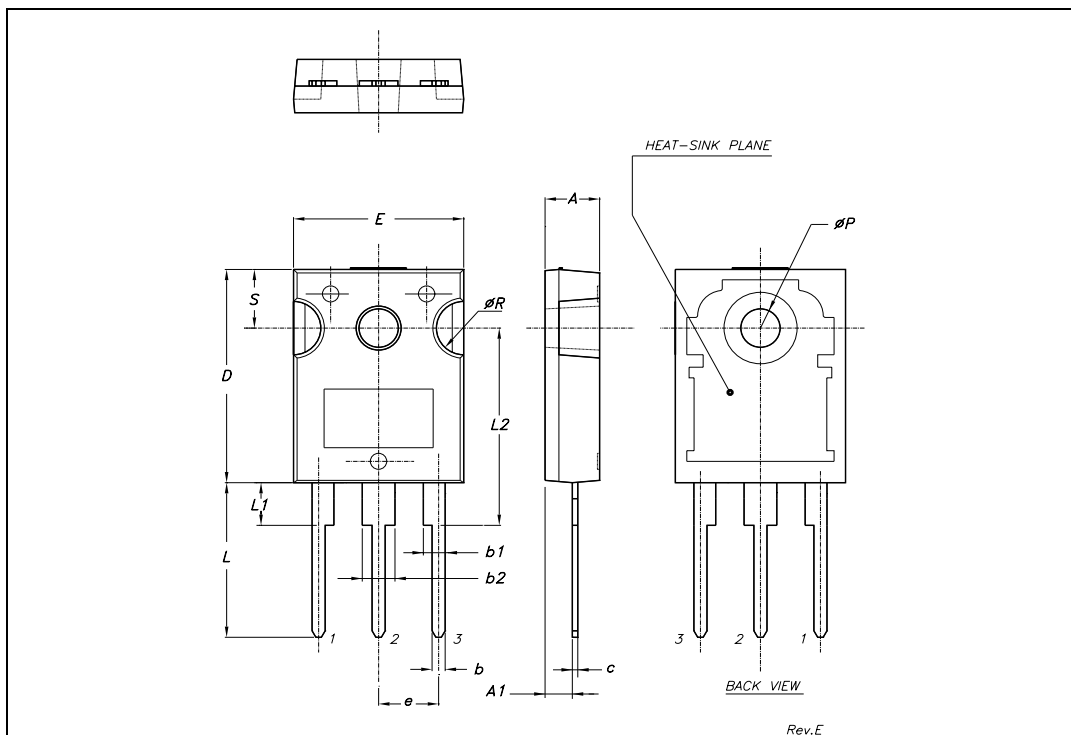


Table 9: Revision History

| Date        | Revision | Description of Changes    |
|-------------|----------|---------------------------|
| 07-Sep-2005 | 1        | First Release.            |
| 28-Sep-2005 | 2        | Symbol changed in Table 5 |
| 14-Oct-2005 | 3        | Modified curves 5,8       |

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