



# STP25NM60N - STF25NM60N STB25NM60N/-1 - STW25NM60N

N-CHANNEL 650 @Tjmax-0.140Ω-20A TO-220/FP/D<sup>2</sup>/I<sup>2</sup>PAK/TO-247  
SECOND GENERATION MDmesh™ MOSFET

PRODUCT PREVIEW

**Table 1: General Features**

| TYPE         | V <sub>DS</sub><br>(@T <sub>jmax</sub> ) | R <sub>DS(on)</sub> | I <sub>D</sub> |
|--------------|--|---------------------|----------------|
| STB25NM60N-1 | 650 V                                    | < 0.170 Ω           | 20 A           |
| STF25NM60N   | 650 V                                    | < 0.170 Ω           | 20(*) A        |
| STP25NM60N   | 650 V                                    | < 0.170 Ω           | 20 A           |
| STW25NM60N   | 650 V                                    | < 0.170 Ω           | 20 A           |
| STB25NM60NT4 | 650 V                                    | < 0.170 Ω           | 20 A           |

- WORLD'S LOWEST ON RESISTANCE
- TYPICAL R<sub>DS(on)</sub> = 0.140 Ω
- HIGH dv/dt AND AVALANCHE CAPABILITIES
- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE

## DESCRIPTION

The **STP25NM60N** 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 the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters

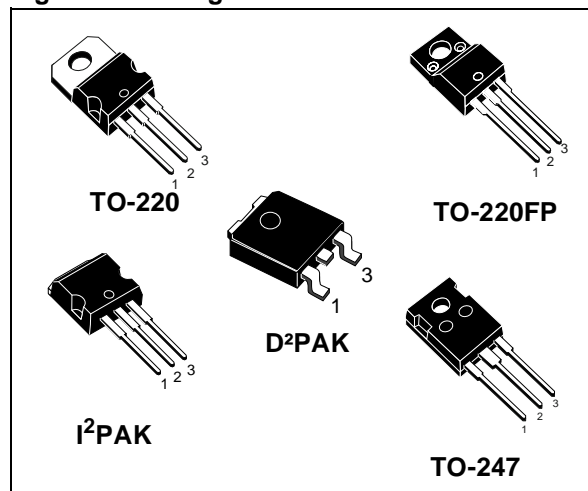
## APPLICATIONS

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

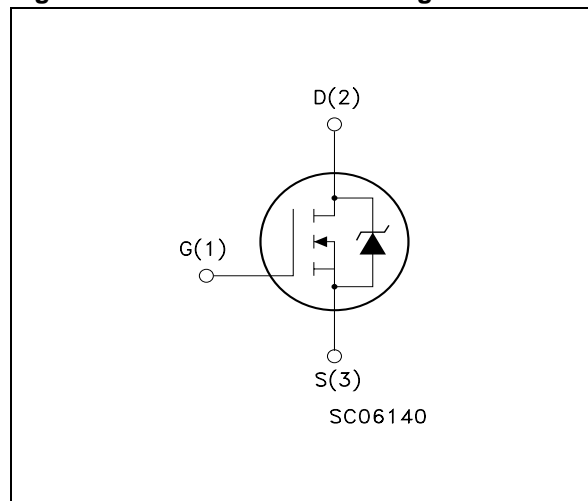
**Table 2: Order Code**

| SALES TYPE   | MARKING  | PACKAGE            | PACKAGING   |
|--------------|----------|--------------------|-------------|
| STB25NM60N-1 | B25NM60N | I <sup>2</sup> PAK | TUBE        |
| STF25NM60N   | F25NM60N | TO-220FP           | TUBE        |
| STP25NM60N   | P25NM60N | TO-220             | TUBE        |
| STW25NM60N   | W25NM60N | TO-247             | TUBE        |
| STB25NM60NT4 | B25NM60N | D <sup>2</sup> PAK | TAPE & REEL |

**Figure 1: Package**



**Figure 2: Internal Schematic Diagram**



Rev. 1

**Table 3: Absolute Maximum ratings**

| Symbol              | Parameter  | Value  |          | Unit |
|---------------------|--|--|----------|------|
|                     |  | TO-220/I <sup>2</sup> PAK<br>TO-247/D <sup>2</sup> PAK | TO-220FP |      |
| V <sub>GS</sub>     | Gate- source Voltage                                 | ± 30   |          | V    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>C</sub> = 25°C  | 20   | 20 (*)   | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>C</sub> = 100°C | 12.8   | 12.8 (*) | A    |
| I <sub>DM</sub> (1) | Drain Current (pulsed)                               | 80   | 80 (*)   | A    |
| P <sub>TOT</sub>    | Total Dissipation at T <sub>C</sub> = 25°C           | 160  | 40       | W    |
|                     | Derating Factor                                      | 1.28   | 0.32     | W/°C |
| dv/dt (2)           | Peak Diode Recovery voltage slope                    | TBD  |          | V/ns |
| T <sub>stg</sub>    | Storage Temperature                                  | - 55 to 150  |          | °C   |
| T <sub>j</sub>      | Max. Operating Junction Temperature                  | 150  |          | °C   |

(\*) Limited only by maximum temperature allowed

(1) Pulse width limited by safe operating area

(2) I<sub>SD</sub> ≤ 20 A, di/dt ≤ 400 A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>.

**Table 4: Thermal Data**

|                       |  | TO-220/I <sup>2</sup> PAK<br>TO-247/D <sup>2</sup> PAK | TO-220FP |      |
|-----------------------|--|--|----------|------|
| R <sub>thj-case</sub> | Thermal Resistance Junction-case Max           | 0.78   | 3.1      | °C/W |
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient Max        | 62.5   |          | °C/W |
| T <sub>l</sub>        | Maximum Lead Temperature For Soldering Purpose | 300  |          | °C   |

**Table 5: Avalanche Characteristics**

| Symbol          | Parameter  | Max Value | Unit |
|-----------------|--|-----------|------|
| I <sub>AR</sub> | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>j</sub> max)                                | TBD       | 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) | TBD       | mJ   |

**ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> =25°C UNLESS OTHERWISE SPECIFIED)**

**Table 6: On /Off**

| Symbol               | Parameter   | Test Conditions  | Min. | Typ.  | Max.    | Unit     |
|----------------------|---|--|------|-------|---------|----------|
| V <sub>(BR)DSS</sub> | Drain-source Breakdown Voltage                        | I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0   | 600  |       |         | V        |
| I <sub>DSS</sub>     | Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0) | V <sub>DS</sub> = Max Rating<br>V <sub>DS</sub> = Max Rating, T <sub>C</sub> = 125°C |      |       | 1<br>10 | μA<br>μA |
| I <sub>GSS</sub>     | Gate-body Leakage Current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ± 30 V   |      |       | ± 100   | nA       |
| V <sub>GS(th)</sub>  | Gate Threshold Voltage                                | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                          | 2    | 3     | 4       | V        |
| R <sub>DS(on)</sub>  | Static Drain-source On Resistance                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 10 A  |      | 0.140 | 0.170   | Ω        |

**ELECTRICAL CHARACTERISTICS (CONTINUED)**

**Table 7: Dynamic**

| Symbol  | Parameter   | Test Conditions   | Min. | Typ.                     | Max. | Unit                 |
|---|---|---|------|--------------------------|------|----------------------|
| $g_{fs}$ (1)                                  | Forward Transconductance  | $V_{DS} = 15V$ , $I_D = 10A$  |      | 17                       |      | S                    |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$           | Input Capacitance<br>Output Capacitance<br>Reverse Transfer Capacitance | $V_{DS} = 25V$ , $f = 1MHz$ ,<br>$V_{GS} = 0$   |      | TBD<br>TBD<br>TBD        |      | pF<br>pF<br>pF       |
| $C_{OSS\ eq}$ (3).                            | Equivalent Output Capacitance   | $V_{GS} = 0V$ , $V_{DS} = 0$ to $480V$  |      | TBD                      |      | pF                   |
| $R_G$   | Gate Input Resistance   | $f=1MHz$ Gate DC Bias = 0<br>Test Signal Level = 20mV<br>Open Drain                       |      | 2                        |      | $\Omega$             |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on Delay Time<br>Rise Time<br>Turn-off-Delay Time<br>Fall Time     | $V_{DD} = 480V$ , $I_D = 12.5A$ ,<br>$R_G = 4.7\Omega$ , $V_{GS} = 10V$<br>(see Figure 4) |      | TBD<br>TBD<br>TBD<br>TBD |      | 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            | $V_{DD} = 480V$ , $I_D = 25A$ ,<br>$V_{GS} = 10V$<br>(see Figure 7)                       |      | TBD<br>TBD<br>TBD        |      | nC<br>nC<br>nC       |

**Table 8: Source Drain Diode**

| Symbol                            | Parameter  | Test Conditions  | Min. | Typ.              | Max.     | Unit               |
|-----------------------------------|--|--|------|-------------------|----------|--------------------|
| $I_{SD}$<br>$I_{SDM}$ (2)         | Source-drain Current<br>Source-drain Current (pulsed)                        |  |      |                   | 20<br>80 | A<br>A             |
| $V_{SD}$ (1)                      | Forward On Voltage   | $I_{SD} = 20A$ , $V_{GS} = 0$  |      |                   | 1.3      | V                  |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD} = 25A$ , $di/dt = 100A/\mu s$<br>$V_{DD} = 100V$<br>(see Figure 5)                       |      | TBD<br>TBD<br>TBD |          | ns<br>$\mu C$<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD} = 25A$ , $di/dt = 100A/\mu s$<br>$V_{DD} = 100V$ , $T_j = 150^\circ C$<br>(see Figure 5) |      | TBD<br>TBD<br>TBD |          | ns<br>$\mu C$<br>A |

(1) Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %.

(2) Pulse width limited by safe operating area.

(3)  $C_{OSS\ eq}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{OSS}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$ .

Figure 3: Unclamped Inductive Load Test Circuit

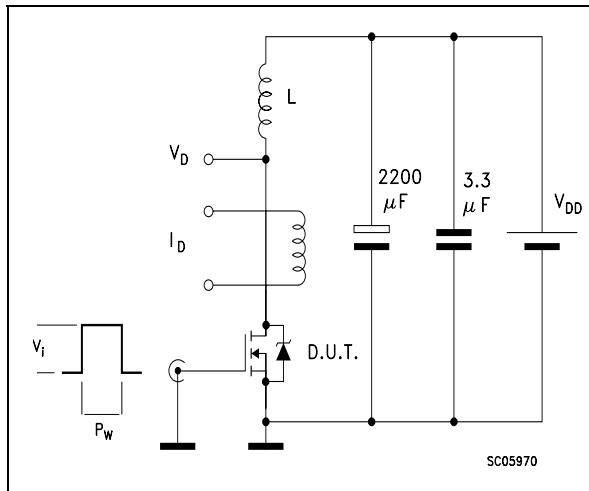


Figure 4: Switching Times Test Circuit For Resistive Load

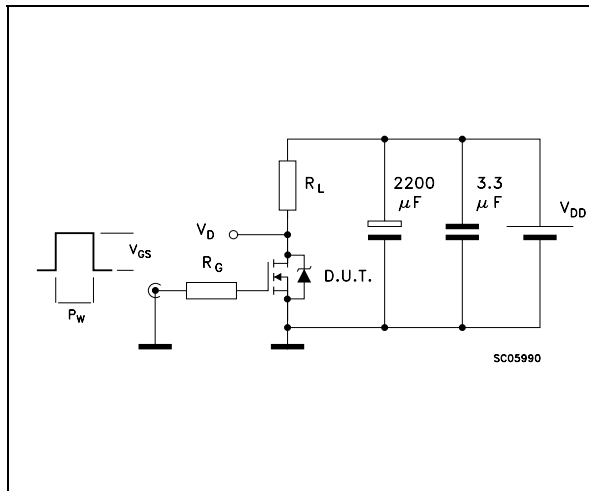


Figure 5: Test Circuit For Inductive Load Switching and Diode Recovery Times

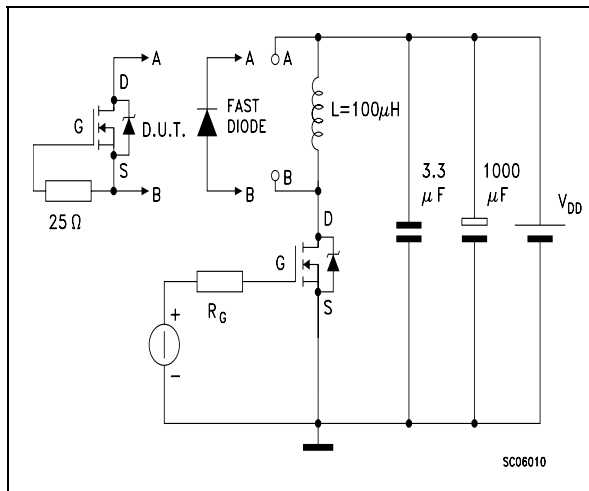


Figure 6: Unclamped Inductive Wafeform

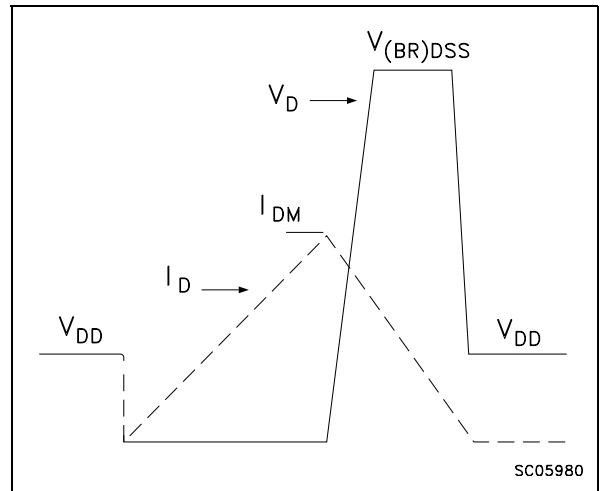
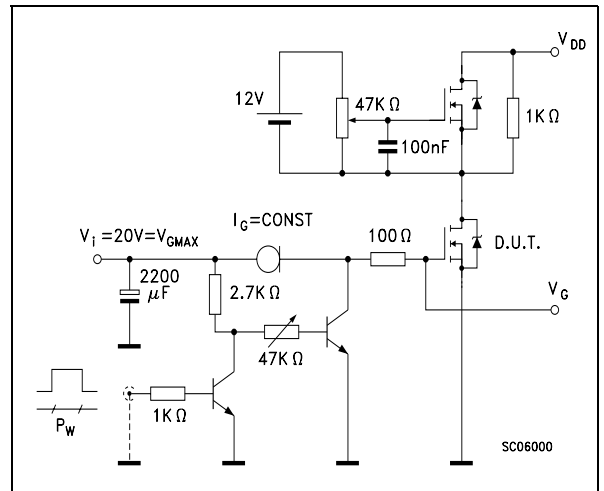
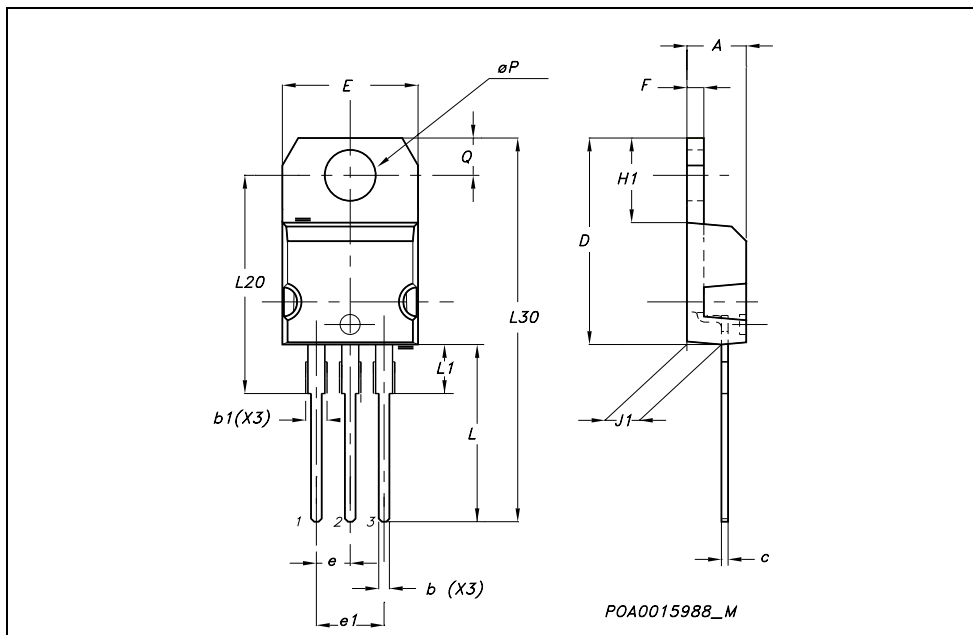


Figure 7: Gate Charge Test Circuit



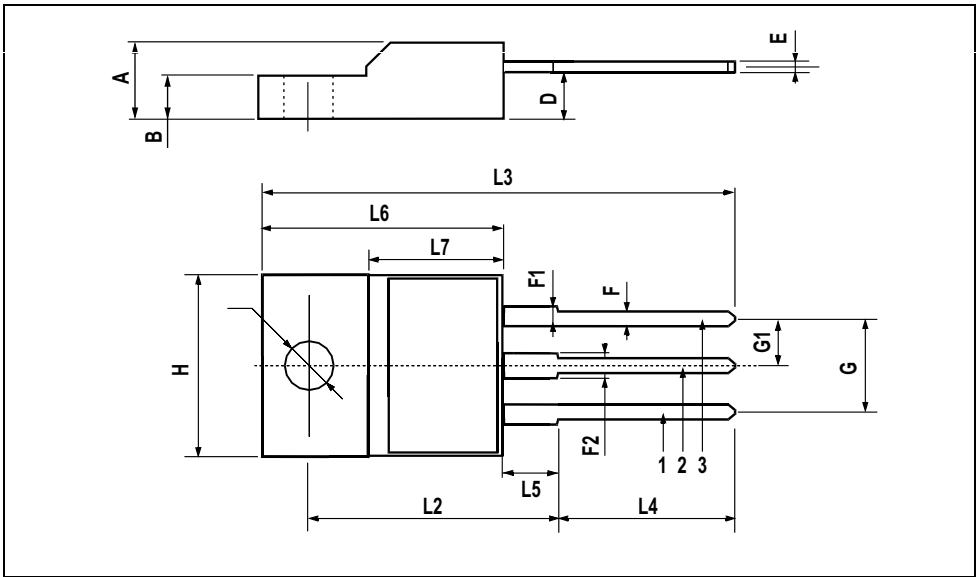
TO-220 MECHANICAL DATA

| 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 |



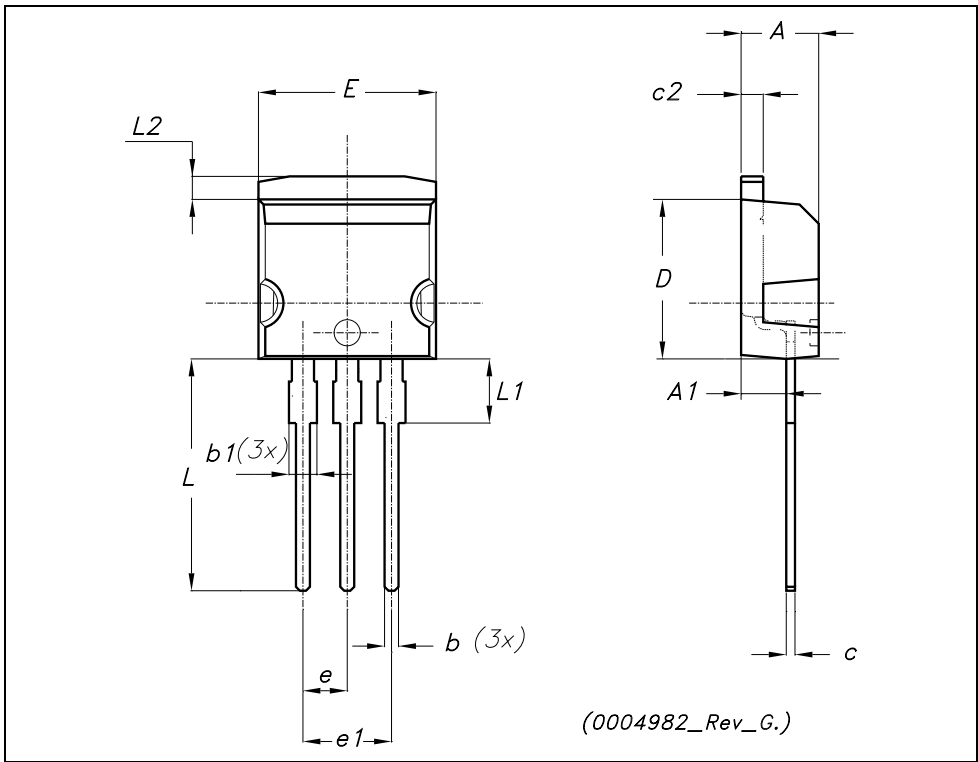
TO-220FP MECHANICAL DATA

| 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 |



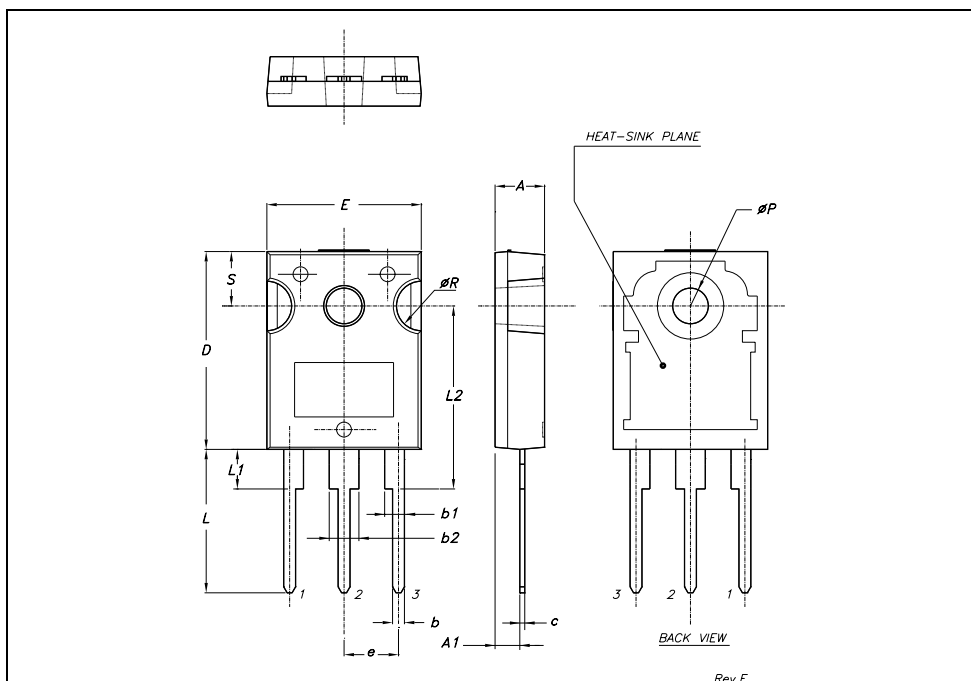
TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA

| 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-247 MECHANICAL DATA

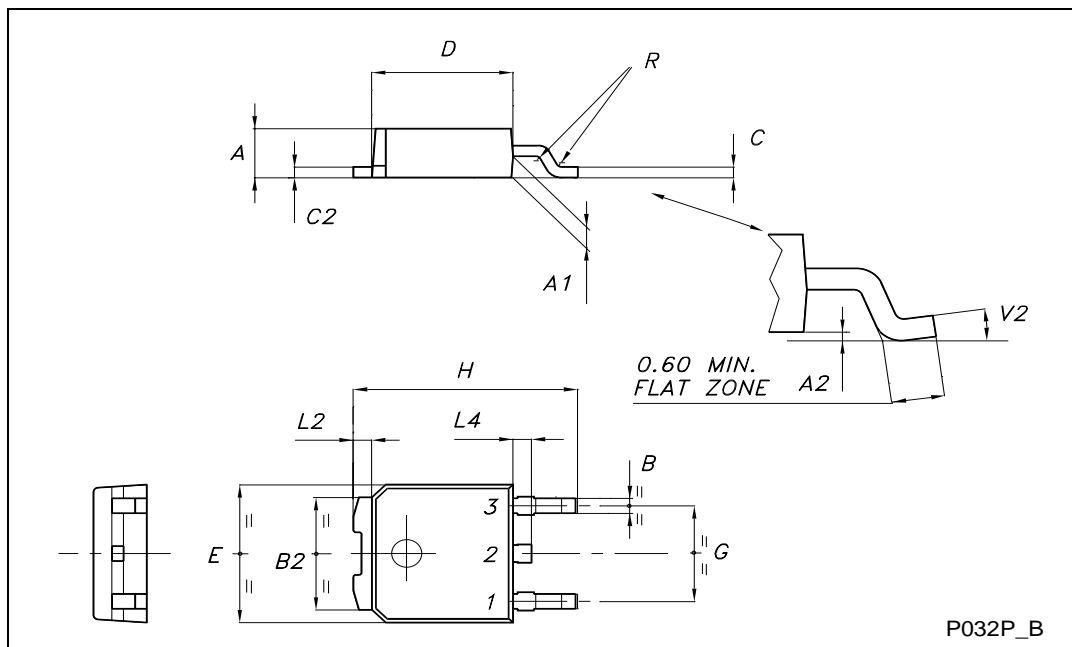
| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.85  |       | 5.15  | 0.19  |       | 0.20  |
| A1   | 2.20  |       | 2.60  | 0.086 |       | 0.102 |
| b    | 1.0   |       | 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 |       |



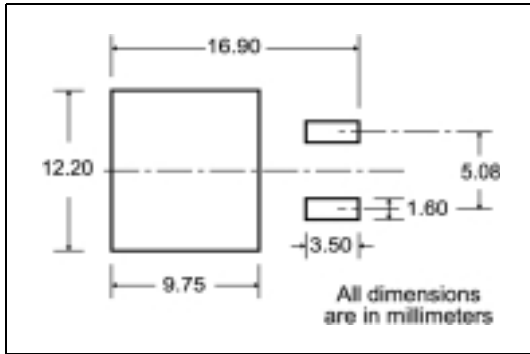


TO-252 (DPAK) MECHANICAL DATA

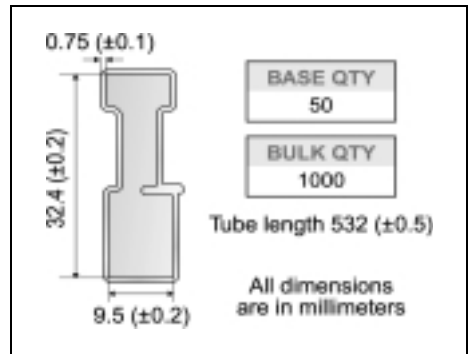
| DIM. | mm   |      |       | inch  |       |       |
|------|------|------|-------|-------|-------|-------|
|      | MIN. | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 2.20 |      | 2.40  | 0.087 |       | 0.094 |
| A1   | 0.90 |      | 1.10  | 0.035 |       | 0.043 |
| A2   | 0.03 |      | 0.23  | 0.001 |       | 0.009 |
| B    | 0.64 |      | 0.90  | 0.025 |       | 0.035 |
| B2   | 5.20 |      | 5.40  | 0.204 |       | 0.213 |
| C    | 0.45 |      | 0.60  | 0.018 |       | 0.024 |
| C2   | 0.48 |      | 0.60  | 0.019 |       | 0.024 |
| D    | 6.00 |      | 6.20  | 0.236 |       | 0.244 |
| E    | 6.40 |      | 6.60  | 0.252 |       | 0.260 |
| G    | 4.40 |      | 4.60  | 0.173 |       | 0.181 |
| H    | 9.35 |      | 10.10 | 0.368 |       | 0.398 |
| L2   |      | 0.8  |       |       | 0.031 |       |
| L4   | 0.60 |      | 1.00  | 0.024 |       | 0.039 |
| V2   | 0°   |      | 8°    | 0°    |       | 0°    |



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



**TUBE SHIPMENT (no suffix)\***



**TAPE AND REEL SHIPMENT (suffix "T4")\***

**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

**Table 9: Revision History**

| Date        | Revision | Description of Changes |
|-------------|----------|------------------------|
| 30-Nov-2004 | 1        | First Release.         |

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