



# STB15NM60N - STF/I15NM60N STP15NM60N - STW15NM60N

N-channel 600V - 0.270Ω - 14A - D<sup>2</sup>/I<sup>2</sup>PAK - TO-220/FP - TO-247  
Second generation MDmesh™ Power MOSFET

## Features

| Type       | V <sub>DSS</sub><br>(@T <sub>jmax</sub> ) | R <sub>DS(on)</sub> | I <sub>D</sub>     |
|------------|-------------------------------------------|---------------------|--------------------|
| STB15NM60N | 650V                                      | < 0.299Ω            | 14A                |
| STI15NM60N | 650V                                      | < 0.299Ω            | 14A                |
| STF15NM60N | 650V                                      | < 0.299Ω            | 14A <sup>(1)</sup> |
| 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

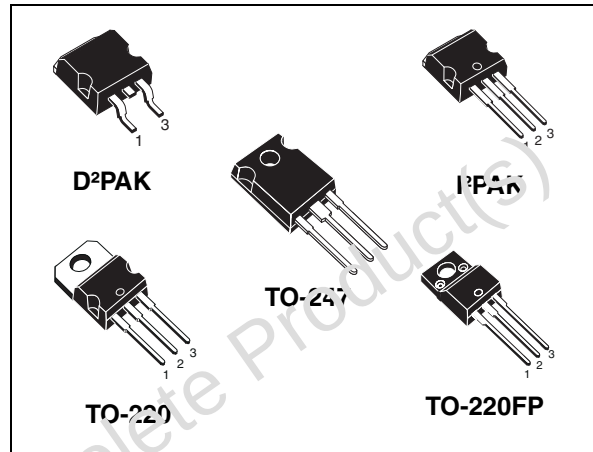
This series of devices implements the second generation of MDmesh™ Technology. This revolutionary Power MOSFET associates a new vertical structure to the Company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency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

## Application

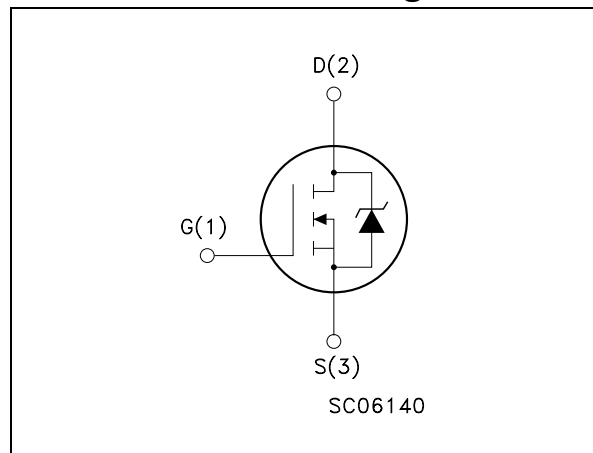
- Switching applications

## Order codes

| Part number | Marking  | Package            | Packaging   |
|-------------|----------|--------------------|-------------|
| STB15NM60N  | B15NM60N | D <sup>2</sup> PAK | Tape & reel |
| STI15NM60N  | I15NM60N | I <sup>2</sup> 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 <sup>2</sup> PAK/I <sup>2</sup> PAK<br>TO-220/TO-247 | TO-220FP          |      |
| V <sub>DS</sub>                    | Drain-source voltage (V <sub>GS</sub> =0)                                                                  | 600                                                    |                   | V    |
| V <sub>GS</sub>                    | Gate-source voltage                                                                                        | ± 25                                                   |                   | V    |
| I <sub>D</sub>                     | Drain current (continuous) at T <sub>C</sub> = 25°C                                                        | 14                                                     | 14 <sup>(1)</sup> | A    |
| I <sub>D</sub>                     | Drain current (continuous) at T <sub>C</sub> = 100°C                                                       | 9                                                      | 9 <sup>(1)</sup>  | A    |
| I <sub>DM</sub> <sup>(2)</sup>     | Drain current (pulsed)                                                                                     | 56                                                     | 56 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>                   | Total dissipation at T <sub>C</sub> = 25°C                                                                 | 125                                                    | 30                | W    |
| dv/dt <sup>(3)</sup>               | Peak diode recovery voltage slope                                                                          | 15                                                     |                   | V/ns |
| V <sub>ISO</sub>                   | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; T <sub>C</sub> =25°C) | --                                                     | 2500              | V    |
| T <sub>j</sub><br>T <sub>stg</sub> | Operating junction temperature<br>Storage temperature                                                      | -55 to 150                                             |                   | °C   |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I<sub>SD</sub> ≤ 14A, di/dt ≤ 400A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 2. Thermal data**

| Symbol                | Parameter                                       | D <sup>2</sup> PAK/I <sup>2</sup> PAK<br>TO-220/TO-247 | TO-220FP | Unit |
|-----------------------|-------------------------------------------------|--------------------------------------------------------|----------|------|
| R <sub>thj-case</sub> | Thermal resistance junction-case max            | 1                                                      | 4.2      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-amb max             | 62.5                                                   |          | °C/W |
| T <sub>l</sub>        | Maximum lead temperature for soldering purposes | 300                                                    |          | °C   |

**Table 3. 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)                            | 6         | A    |
| E <sub>AS</sub> | Single pulse avalanche energy (starting T <sub>j</sub> =25°C, I <sub>D</sub> =I <sub>AS</sub> , V <sub>DD</sub> = 50V) | 300       | mJ   |

## 2 Electrical characteristics

(T<sub>CASE</sub>=25°C unless otherwise specified)

**Table 4. On/off states**

| Symbol               | Parameter                                             | Test conditions                                                        | Min. | Typ.  | Max.  | Unit |
|----------------------|-------------------------------------------------------|------------------------------------------------------------------------|------|-------|-------|------|
| V <sub>(BR)DSS</sub> | Drain-source breakdown voltage                        | I <sub>D</sub> = 1mA, V <sub>GS</sub> = 0                              | 600  |       |       | V    |
| dv/dt <sup>(1)</sup> | Drain-source voltage slope                            | V <sub>DD</sub> = 480V, I <sub>D</sub> = 14A,<br>V <sub>GS</sub> = 10V | 30   |       |       | V/ns |
| 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, @ 125°C |      |       | 100   | μA   |
| I <sub>GSS</sub>     | Gate body leakage current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ±20V                                                 |      |       | 100   | nA   |
| V <sub>GS(th)</sub>  | Gate threshold voltage                                | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA             | 2    | 3     | 4     | V    |
| R <sub>DS(on)</sub>  | Static drain-source on resistance                     | V <sub>GS</sub> = 10V, I <sub>D</sub> = 1A                             |      | 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 <sub>fs</sub> <sup>(1)</sup>                           | Forward transconductance                                                | V <sub>DS</sub> = 15V, I <sub>D</sub> = 7A                                               |      | 10                |      | S              |
| C <sub>iss</sub><br>C <sub>oss</sub><br>C <sub>rss</sub> | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | V <sub>DS</sub> = 50V, f = 1MHz,<br>V <sub>GS</sub> = 0                                  |      | 1250<br>100<br>10 |      | pF<br>pF<br>pF |
| C <sub>oss eq.</sub> <sup>(2)</sup>                      | Equivalent output capacitance                                           | V <sub>GS</sub> = 0, V <sub>DS</sub> = 0V to 480V                                        |      | 137               |      | pF             |
| R <sub>g</sub>                                           | Gate input resistance                                                   | f = 1MHz Gate DC Bias = 0<br>Test signal level = 20mV open drain                         |      | 6.0               |      | Ω              |
| Q <sub>g</sub><br>Q <sub>gs</sub><br>Q <sub>gd</sub>     | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | V <sub>DD</sub> = 480V, I <sub>D</sub> = 14A<br>V <sub>GS</sub> = 10V<br>(see Figure 18) |      | 37<br>6<br>18     |      | nC<br>nC<br>nC |

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

2. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

**Table 6. Switching times**

| Symbol       | Parameter           | Test conditions                                                                  | Min | Typ | Max | Unit |
|--------------|---------------------|----------------------------------------------------------------------------------|-----|-----|-----|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300V, I_D = 7A,$<br>$R_G = 4.7\Omega, V_{GS} = 10V$<br>(see Figure 17) |     | 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) |                                                                                            |     |     | 50  | A       |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 14A, V_{GS}=0$                                                                   |     |     | 1.3 | V       |
| $t_{rr}$        | Reverse recovery time         | $I_{SD}=14A, di/dt=100A/\mu s,$<br>$V_{DD} = 100V, T_J = 25^\circ C$<br>(see Figure 19)    |     | 390 |     | ns      |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                            |     | 5   |     | $\mu C$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                            |     | 25  |     | A       |
| $t_{rr}$        | Reverse recovery time         | $V_{DD} = 100V$<br>$di/dt=100A/\mu s, I_{SD} = 14A$<br>$T_J = 150^\circ C$ (see Figure 19) |     | 500 |     | ns      |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                            |     | 7   |     | $\mu C$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                            |     | 25  |     | A       |

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration = 300 $\mu s$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220 / D<sup>2</sup>PAK / I<sup>2</sup>PAK

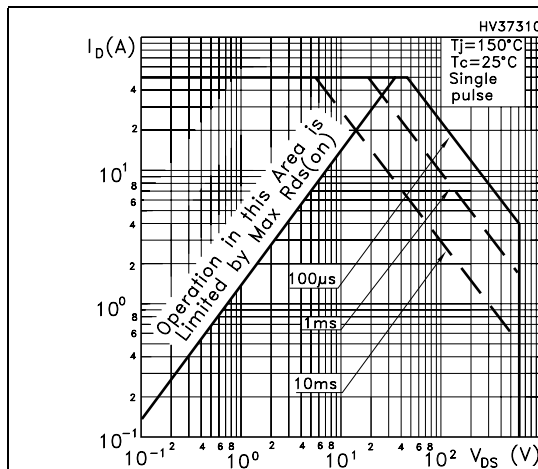


Figure 2. Thermal impedance for TO-220 / D<sup>2</sup>PAK / I<sup>2</sup>PAK

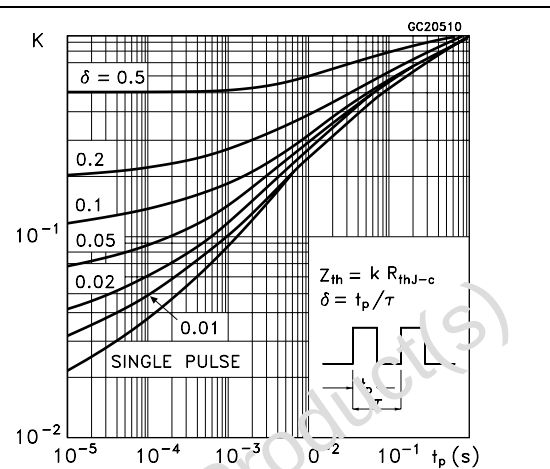


Figure 3. Safe operating area for TO-220FP

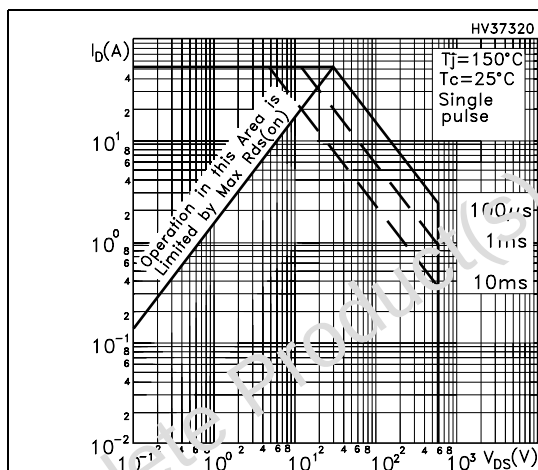


Figure 4. Thermal impedance for TO-220FP

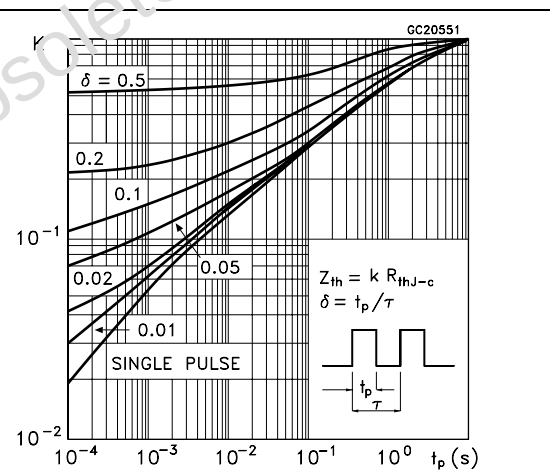


Figure 5. Safe operating area for TO-247

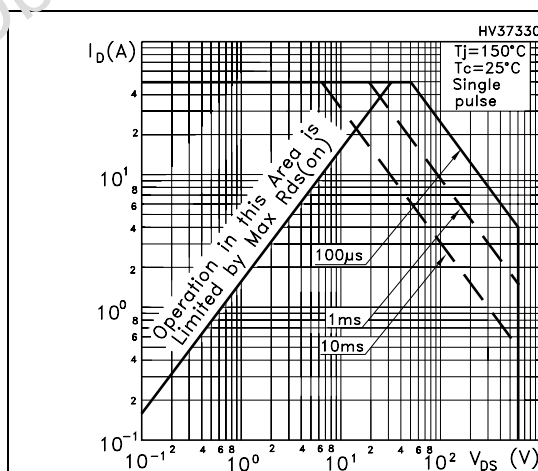


Figure 6. Thermal impedance for TO-247

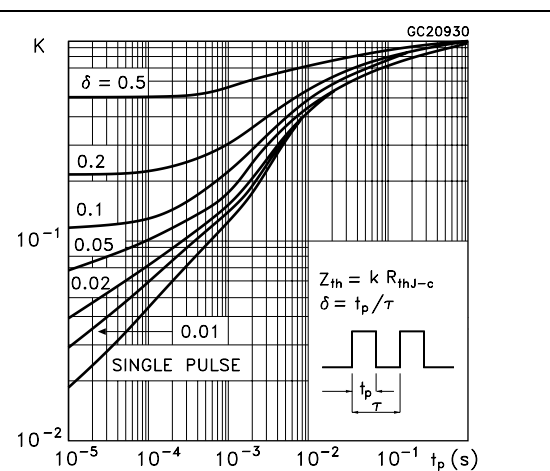


Figure 7. Output characteristics

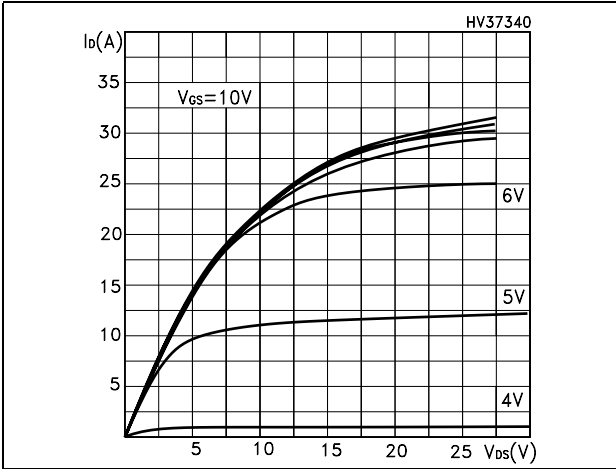


Figure 8. Transfer characteristics

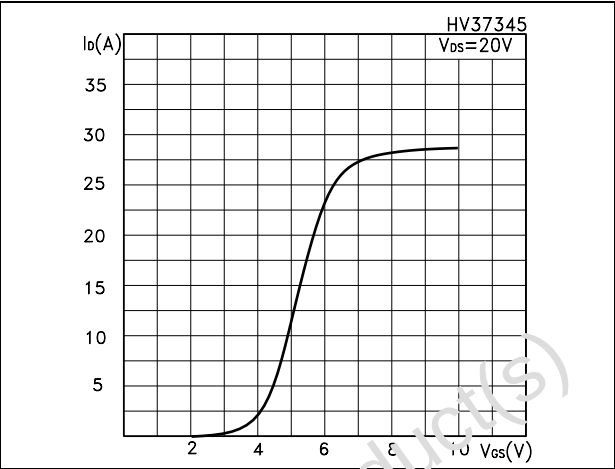


Figure 9. Transconductance

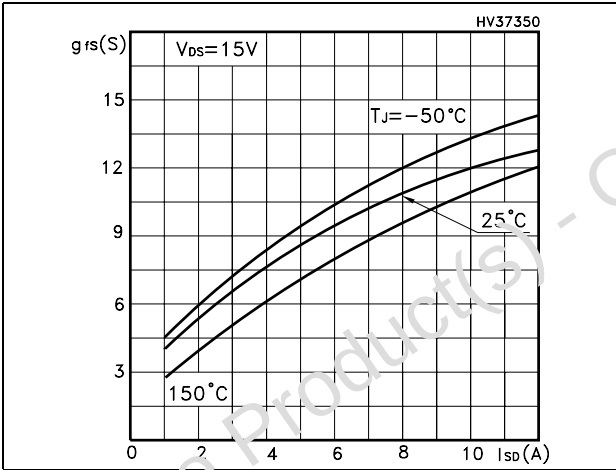


Figure 10. Static drain-source on resistance

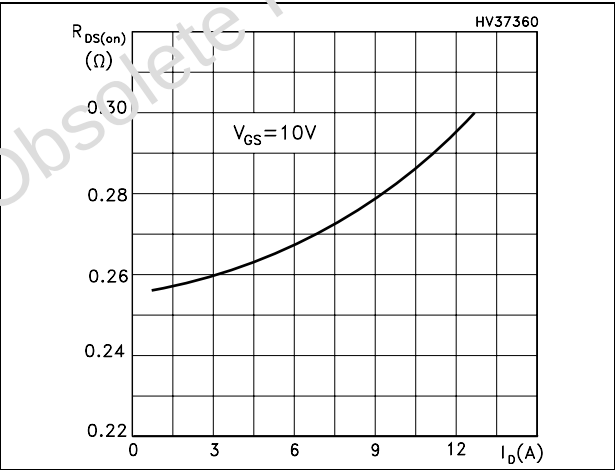


Figure 11. Gate charge vs gate-source voltage

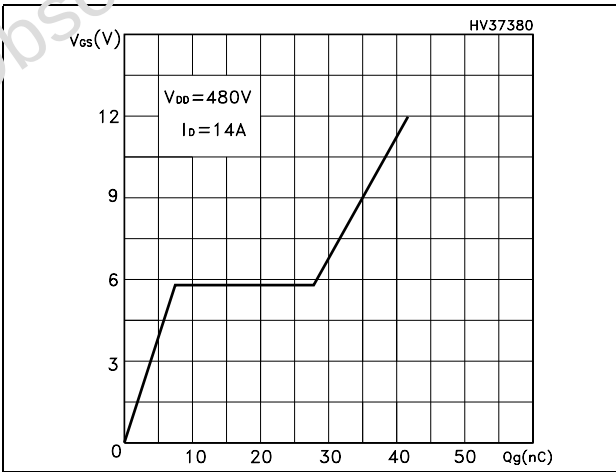


Figure 12. Capacitance variations

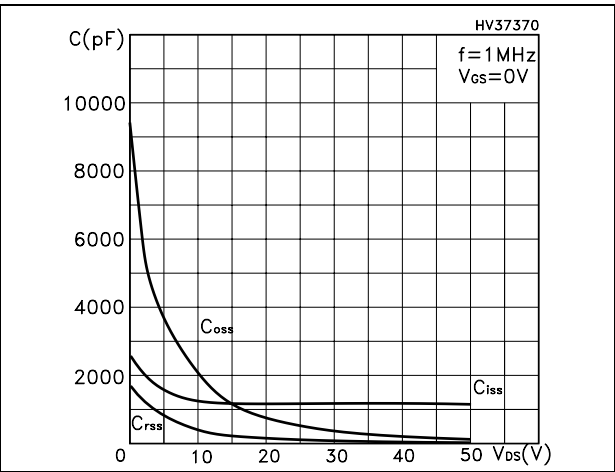


Figure 13. Normalized gate threshold voltage vs temperature

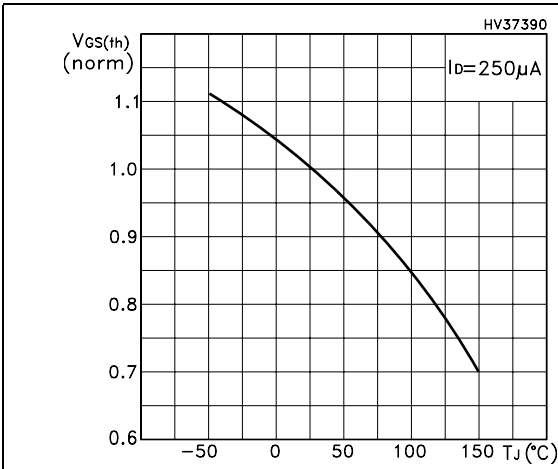


Figure 14. Normalized on resistance vs temperature

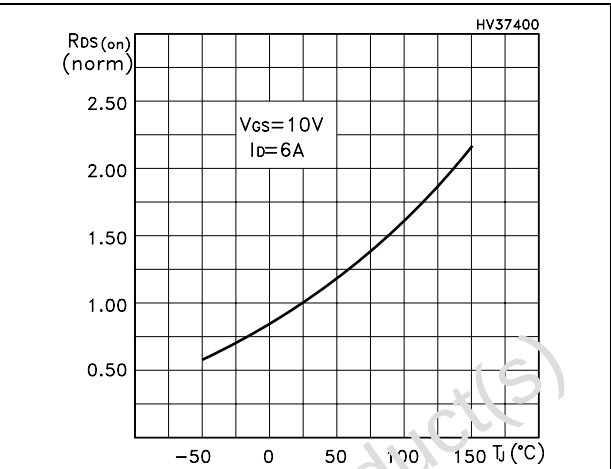


Figure 15. Source-drain diode forward characteristics

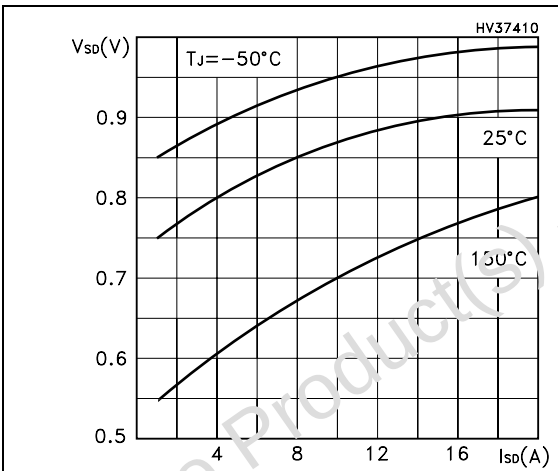
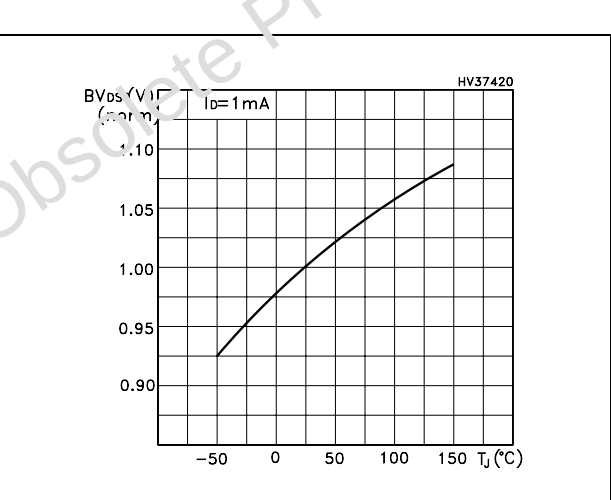


Figure 16. Normalized  $B_{VDS}$  vs temperature



### 3 Test circuit

Figure 17. Switching times test circuit for resistive load

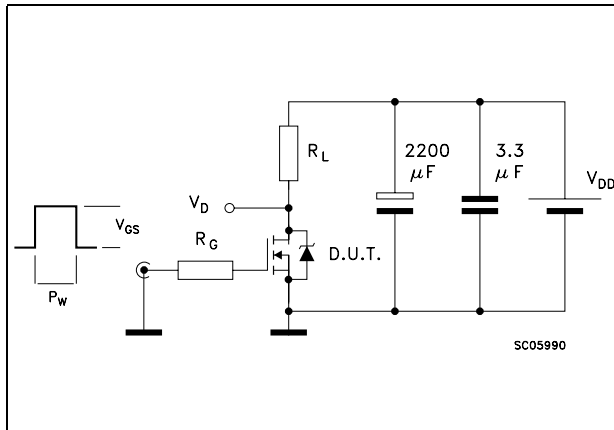


Figure 18. Gate charge test circuit

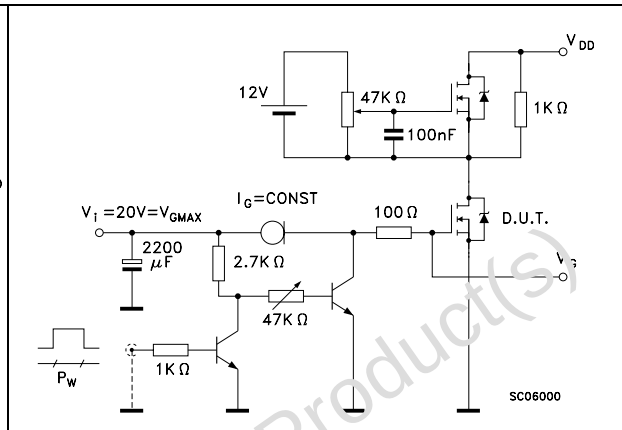


Figure 19. Test circuit for inductive load switching and diode recovery times

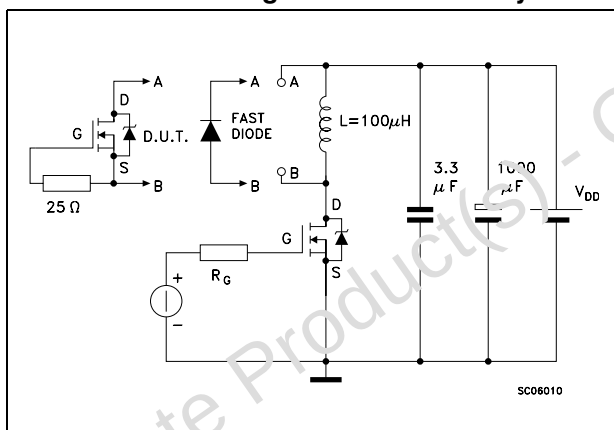


Figure 20. Unclamped Inductive load test circuit

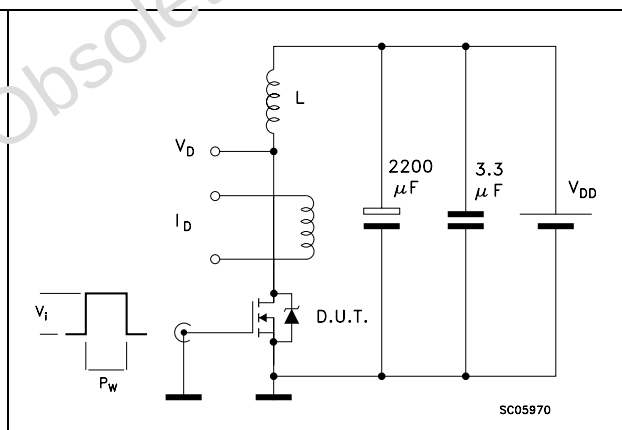


Figure 21. Unclamped inductive waveform

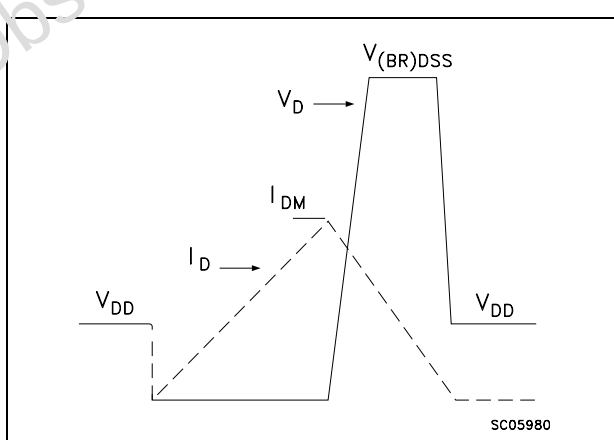
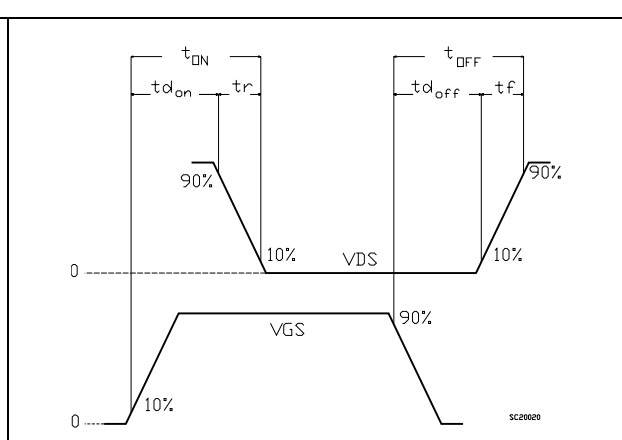


Figure 22. Switching time waveform



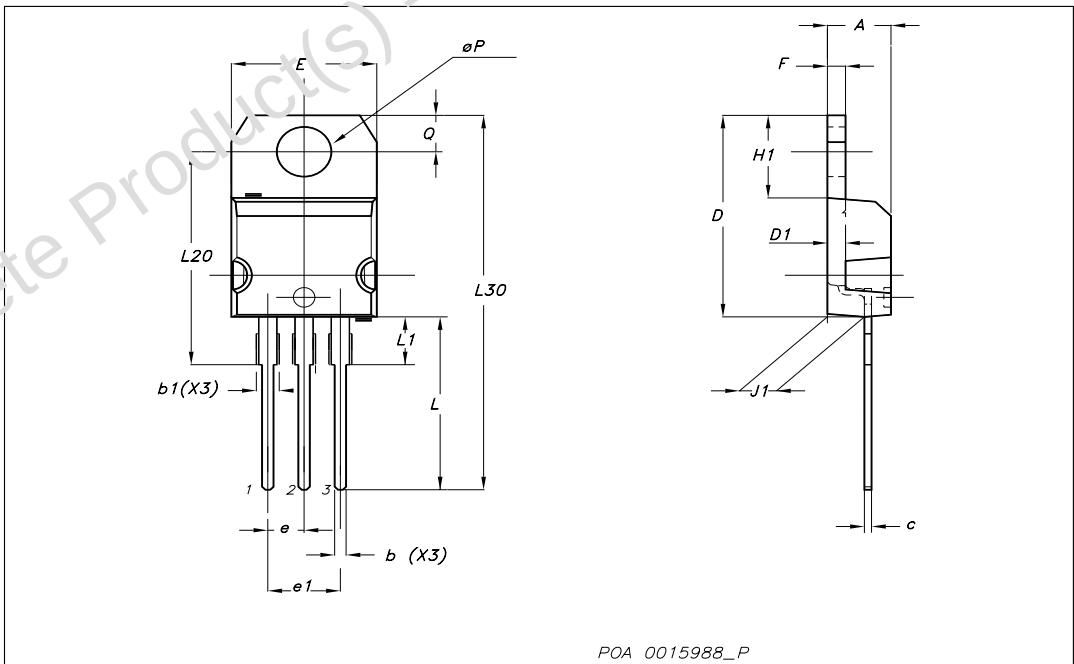
## 4 Package mechanical data

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](http://www.st.com)

Obsolete Product(s) - Obsolete Product(s)

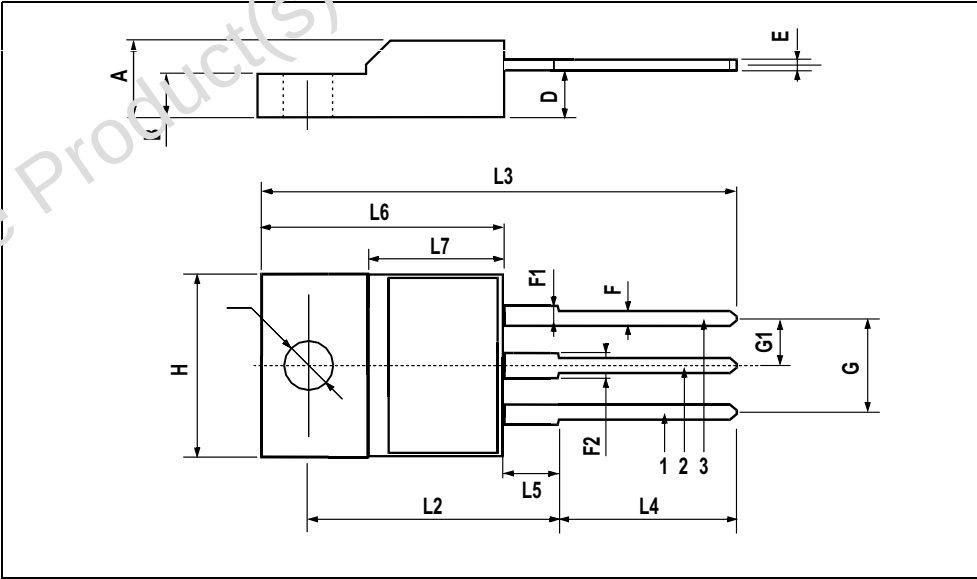
TO-220 mechanical data

| 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   | 0.49  |       | 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 |       |
| ØP  | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q   | 2.65  |       | 2.95  | 0.104 |       | 0.116 |



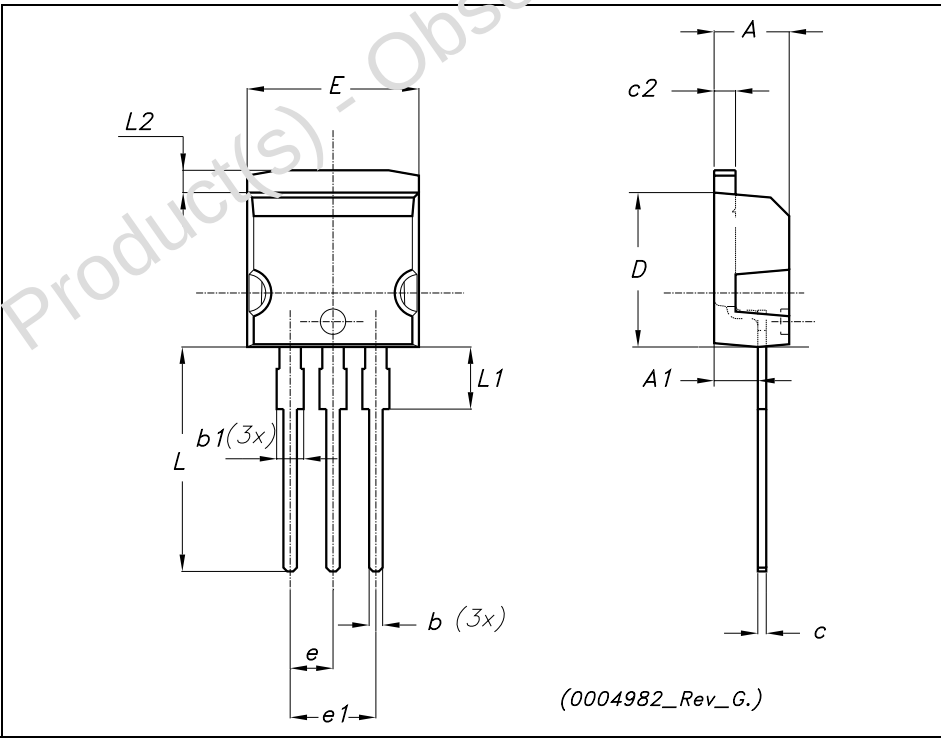
TO-220FP MECHANICAL DATA

| 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 | 0.385 |       | 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 |



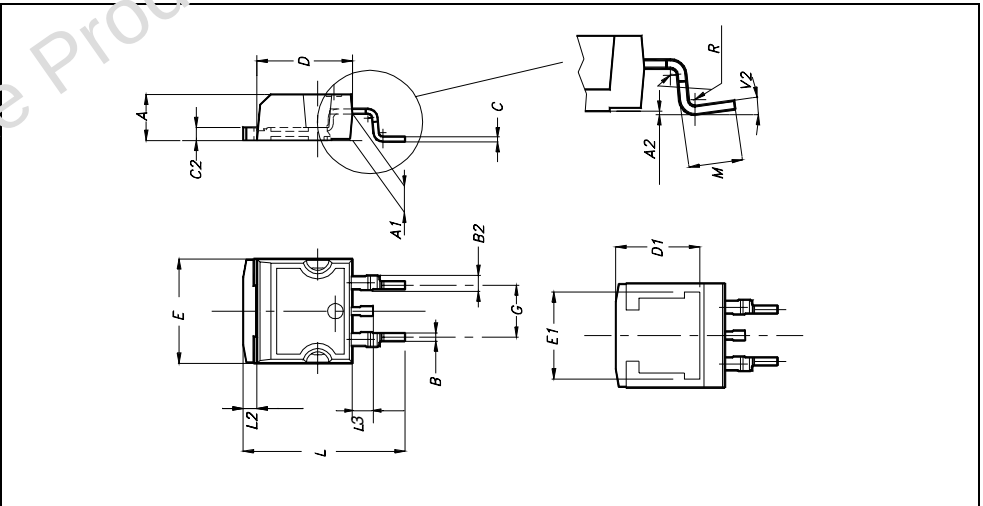
TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA

| 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 |



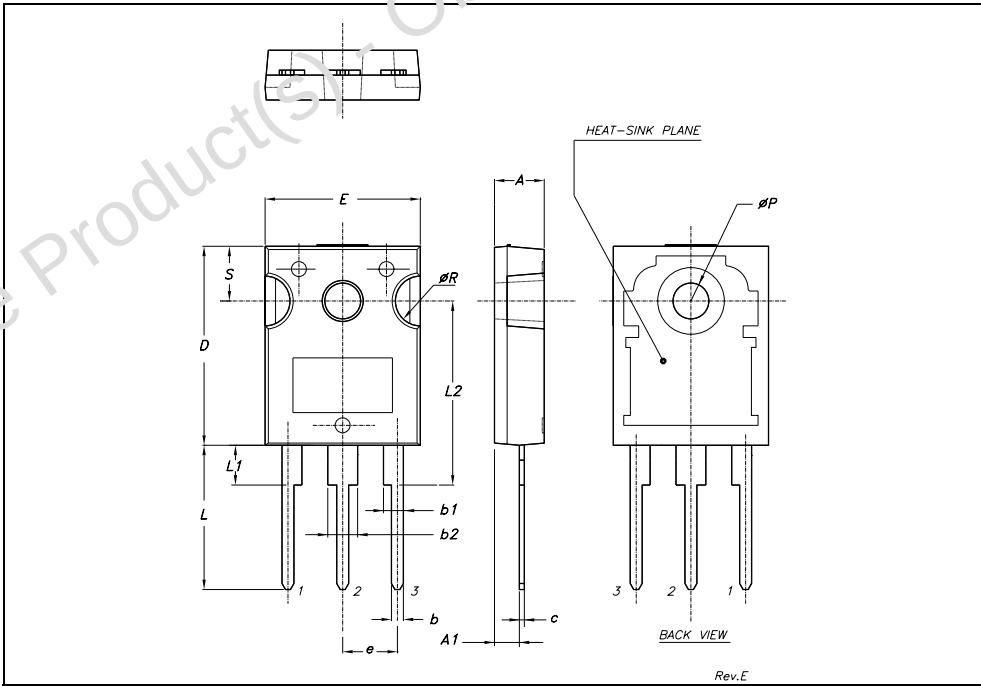
D<sup>2</sup>PAK MECHANICAL DATA

| 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°    |       |       |       |



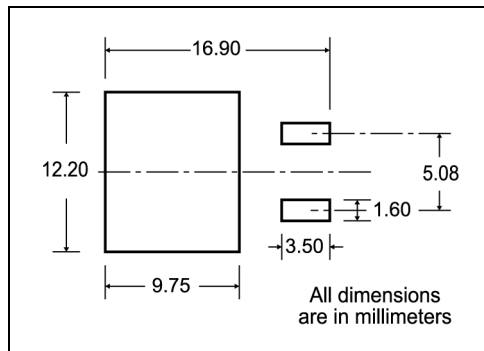
TO-247 MECHANICAL DATA

| 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 |       |

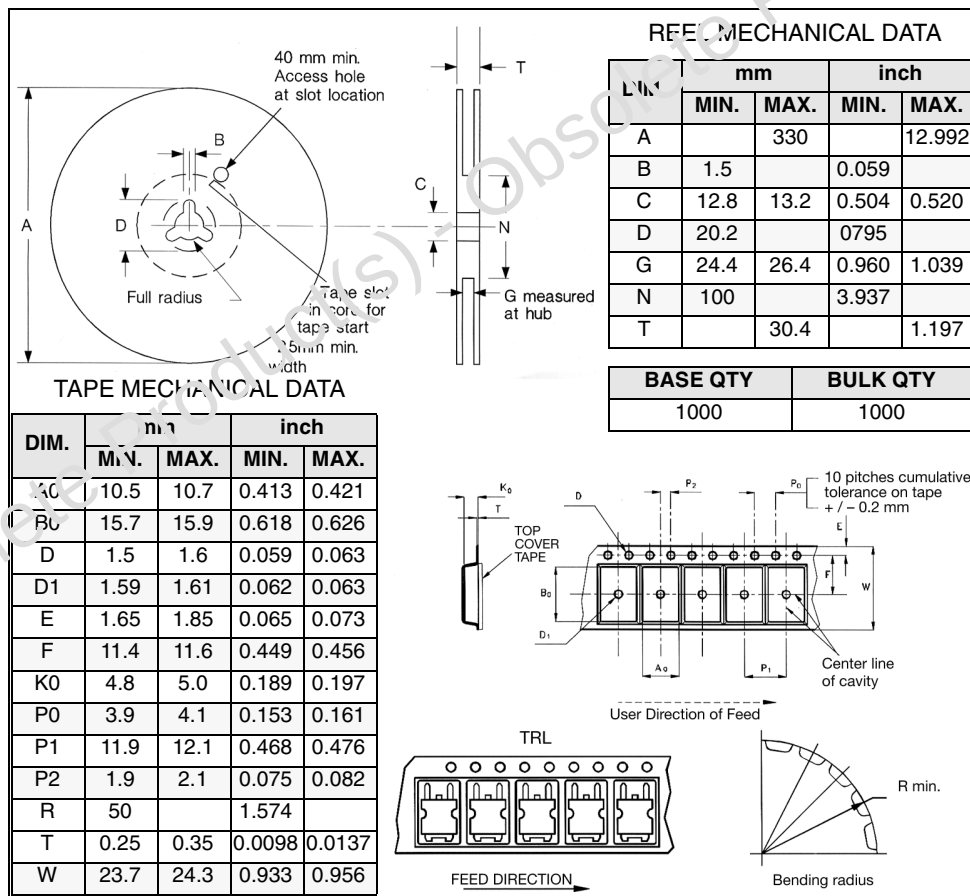


## 5 Packaging mechanical data

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



### TAPE AND REEL SHIPMENT



\* on sales type

## 6 Revision history

**Table 8. Revision history**

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

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