



# STB20NM50FD STF20NM50FD - STP20NM50FD

N-channel 500 V, 0.22  $\Omega$ , 20 A D<sup>2</sup>PAK, TO-220FP, TO-220  
FDmesh™ Power MOSFET (with fast diode)

## Features

| Type        | V <sub>DSS</sub> | R <sub>DS(on)</sub><br>max | R <sub>DS(on)</sub> * Qg | I <sub>D</sub> |
|-------------|------------------|----------------------------|--------------------------|----------------|
| STB20NM50FD | 500 V            | < 0.25 $\Omega$            | 8.36 $\Omega^*$ nC       | 20 A           |
| STF20NM50FD | 500 V            | < 0.25 $\Omega$            | 8.36 $\Omega^*$ nC       | 20 A           |
| STP20NM50FD | 500 V            | < 0.25 $\Omega$            | 8.36 $\Omega^*$ nC       | 20 A           |

- High dv/dt and avalanche capabilities
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Tight process control and high manufacturing yields

## Application

- Switching applications

## Description

The FDmesh™ associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

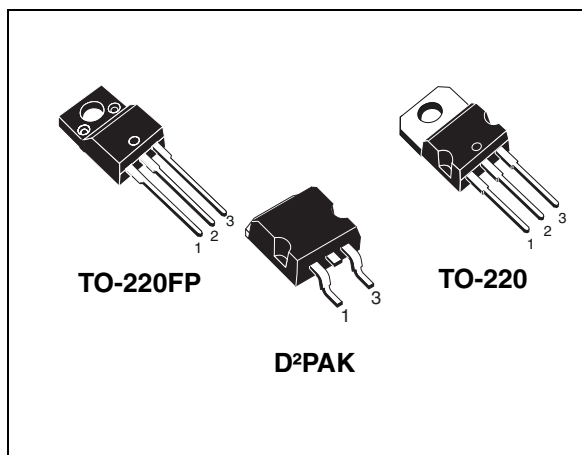


Figure 1. Internal schematic diagram

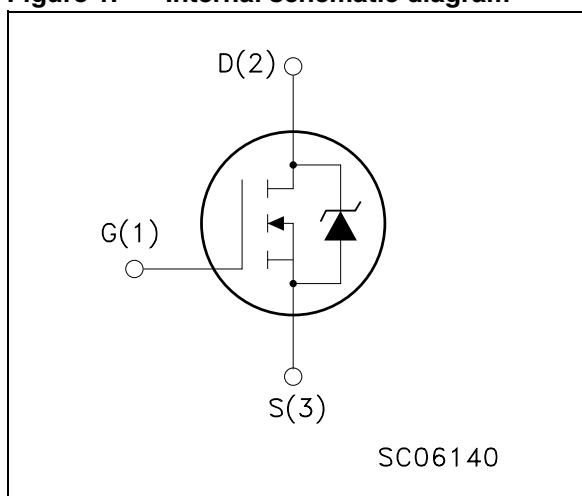


Table 1. Device summary

| Order codes | Marking   | Package            | Packaging     |
|-------------|-----------|--------------------|---------------|
| STB20NM50FD | B20NM50FD | D <sup>2</sup> PAK | Tape and reel |
| STF20NM50FD | F20NM50FD | TO-220FP           | Tube          |
| STP20NM50FD | P20NM50FD | TO-220             | Tube          |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter                                                                                                       | Value                        |                   | Unit |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------|-------------------|------|
|                                |                                                                                                                 | D <sup>2</sup> PAK<br>TO-220 | TO-220FP          |      |
| V <sub>DS</sub>                | Drain-source voltage (V <sub>GS</sub> =0)                                                                       | 500                          |                   | V    |
| 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 <sup>(1)</sup> | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                           | 14                           | 14 <sup>(1)</sup> | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                          | 80                           | 80 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                     | 192                          | 45                | W    |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                                                                               | 20                           |                   | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink<br>(t=1 s; T <sub>C</sub> =25 °C) | --                           | 2500              | V    |
| T <sub>stg</sub>               | Storage temperature                                                                                             | -65 to 150                   |                   | °C   |
| T <sub>j</sub>                 | Operating junction temperature                                                                                  | 150                          |                   | °C   |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I<sub>SD</sub> ≤ 20 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

| Symbol                | Parameter                                       | TO-220 | D <sup>2</sup> PAK | TO-220FP | Unit |
|-----------------------|-------------------------------------------------|--------|--------------------|----------|------|
| R <sub>thj-case</sub> | Thermal resistance junction-case max            | 0.65   |                    | 2.8      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-amb max             | 62.5   | --                 | 62.5     | °C/W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb max             | --     | 30                 | --       | °C/W |
| T <sub>I</sub>        | Maximum lead temperature for soldering purposes | 300    |                    |          | °C   |

**Table 4. Avalanche characteristics**

| Symbol          | Parameter                                                                                                                     | Max value | Unit |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------|-----------|------|
| I <sub>AS</sub> | Avalanche current, repetitive or not-repetitive<br>(pulse width limited by T <sub>j</sub> max)                                | 10        | A    |
| E <sub>AS</sub> | Single pulse avalanche energy<br>(starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AS</sub> , V <sub>DD</sub> = 35 V) | 700       | mJ   |

## 2 Electrical characteristics

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

**Table 5. On/off states**

| Symbol               | Parameter                                             | Test conditions                                                         | Min. | Typ. | Max.    | Unit     |
|----------------------|-------------------------------------------------------|-------------------------------------------------------------------------|------|------|---------|----------|
| V <sub>(BR)DSS</sub> | Drain-source breakdown voltage                        | I <sub>D</sub> = 250 µA, V <sub>GS</sub> = 0                            | 500  |      |         | 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, @ 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             | 3    | 4    | 5       | V        |
| R <sub>DS(on)</sub>  | Static drain-source on resistance                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 10 A                           |      | 0.22 | 0.25    | Ω        |

**Table 6. Dynamic**

| Symbol                                                   | Parameter                                                               | Test conditions                                                                             | Min. | Typ.              | Max. | Unit           |
|----------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------|-------------------|------|----------------|
| g <sub>fs</sub> <sup>(1)</sup>                           | Forward transconductance                                                | V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub> ,<br>I <sub>D</sub> = 10 A    |      | 9                 |      | 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> = 25V, f = 1 MHz,<br>V <sub>GS</sub> = 0                                    |      | 1380<br>290<br>40 |      | 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> = 0 to 400 V                                           |      | 130               |      | pF             |
| R <sub>g</sub>                                           | Gate input resistance                                                   | f=1 MHz Gate DC Bias=0<br>Test signal level=20 mV<br>open drain                             |      | 2.8               |      | 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> = 400 V, I <sub>D</sub> = 20 A<br>V <sub>GS</sub> = 10 V<br>(see Figure 16) |      | 38<br>18<br>10    | 53   | nC<br>nC<br>nC |

1. Pulsed: pulse duration = 300 µs, 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 7. Switching times**

| Symbol        | Parameter             | Test conditions                                                                                                    | Min | Typ | Max | Unit |
|---------------|-----------------------|--------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $t_{d(on)}$   | Turn-on delay time    | $V_{DD} = 250\text{ V}$ , $I_D = 10\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 15) |     | 22  |     | ns   |
| $t_r$         | Rise time             |                                                                                                                    |     | 20  |     | ns   |
| $t_{r(Voff)}$ | Off-voltage rise time | $V_{DD} = 400\text{ V}$ , $I_D = 20\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 15) |     | 6   |     | ns   |
| $t_f$         | Fall time             |                                                                                                                    |     | 15  |     | ns   |
| $t_c$         | Cross-over time       |                                                                                                                    |     | 30  |     | ns   |

**Table 8. Source drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                                | Min | Typ | Max | Unit |
|-----------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                |     |     | 20  | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                |     |     | 80  | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 20\text{ A}$ , $V_{GS} = 0$                                                                                                          |     |     | 1.5 | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$<br>(see Figure 17) |     | 245 |     | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                |     | 2   |     | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                |     | 16  |     | A    |

1. Pulse width limited by safe operating area

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

## 2.1 Electrical characteristics (curves)

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

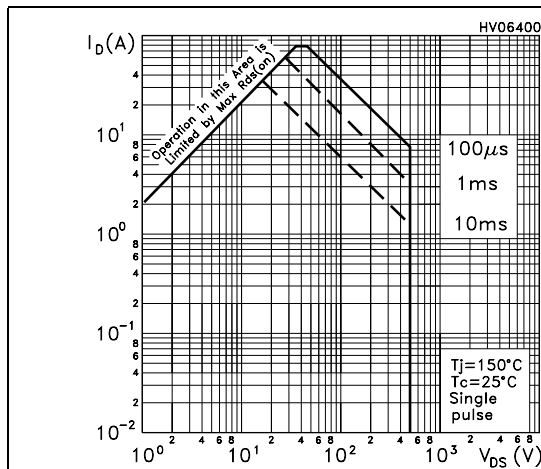


Figure 3. Thermal impedance for TO-220 / D<sup>2</sup>PAK

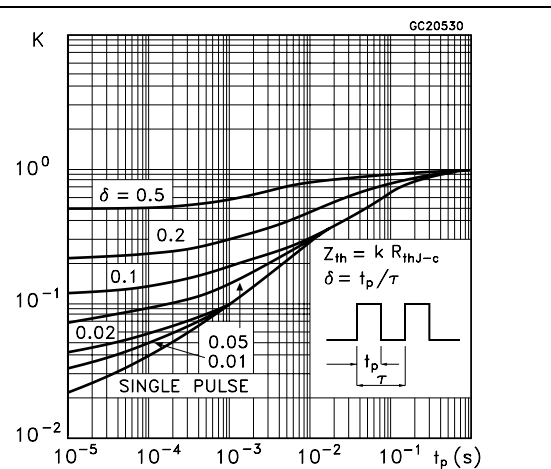


Figure 4. Safe operating area for TO-220FP

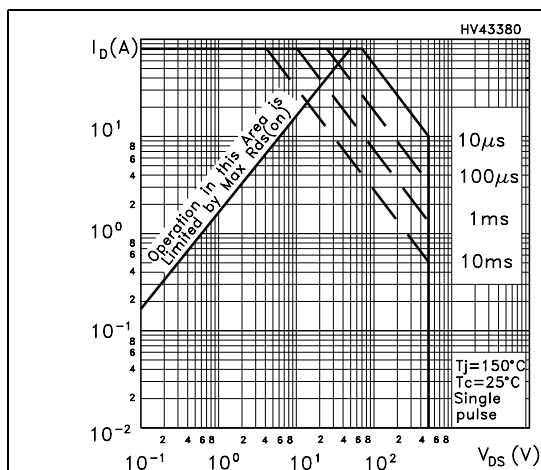


Figure 5. Thermal impedance for TO-220FP

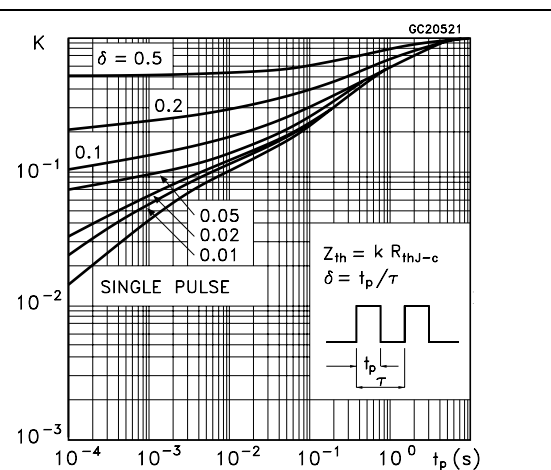


Figure 6. Output characteristics

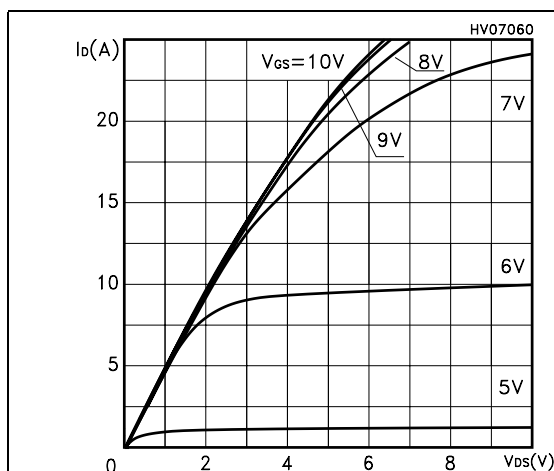


Figure 7. Transfer characteristics

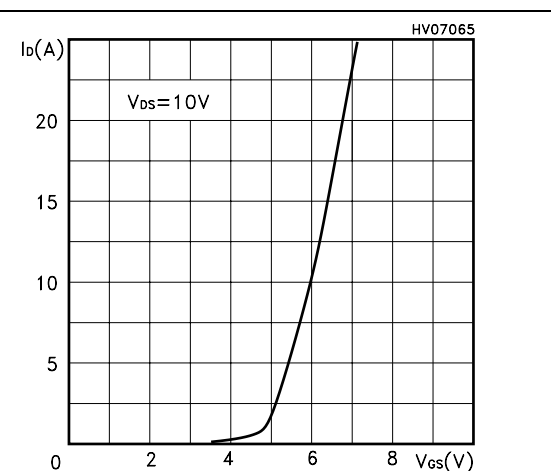


Figure 8. Transconductance

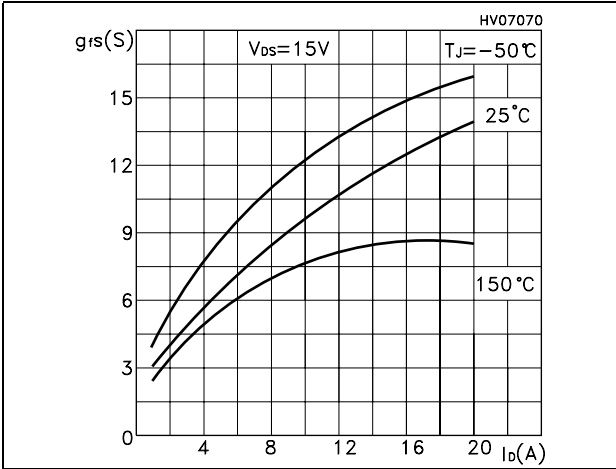


Figure 9. Static drain-source on resistance

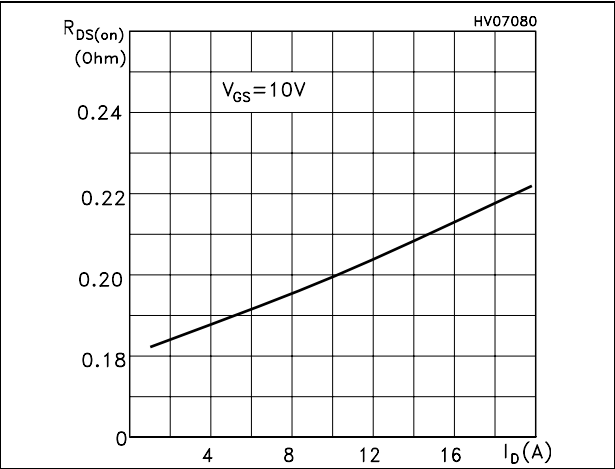


Figure 10. Gate charge vs gate-source voltage

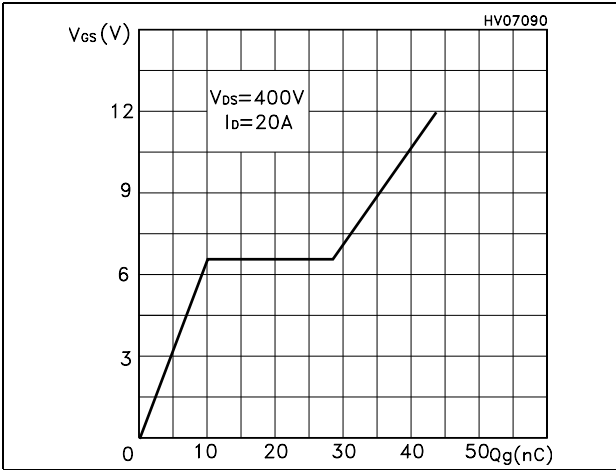


Figure 11. Capacitance variations

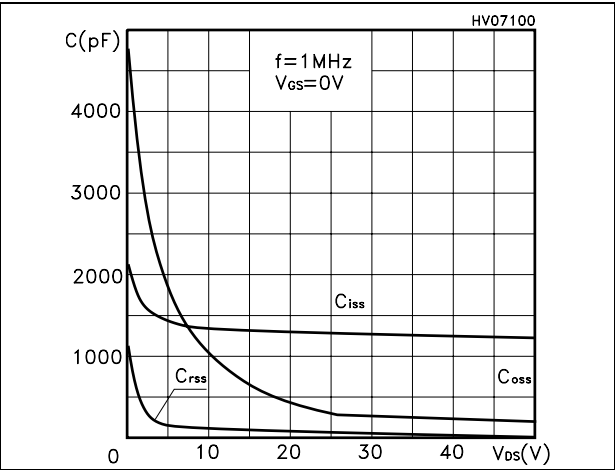


Figure 12. Normalized gate threshold voltage vs temperature

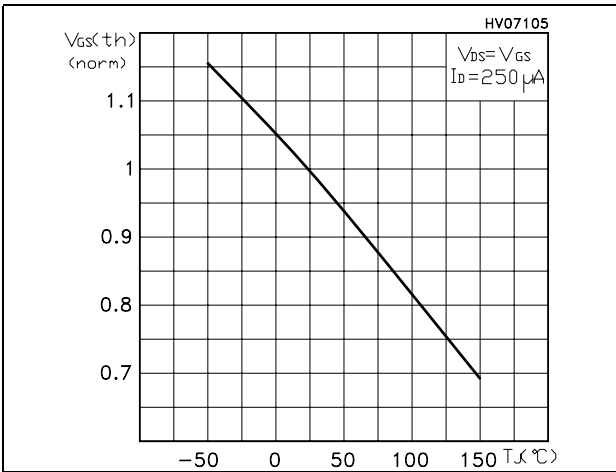
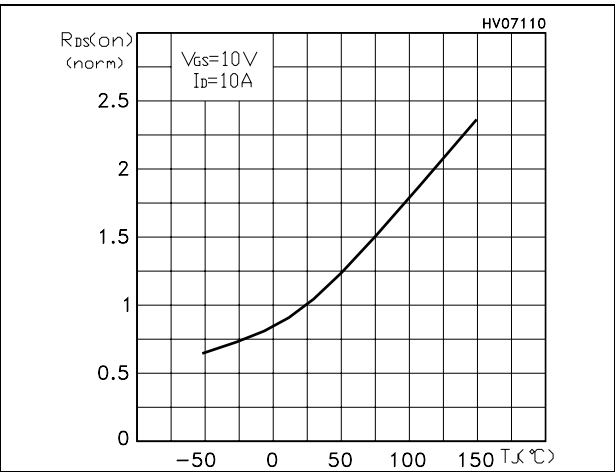
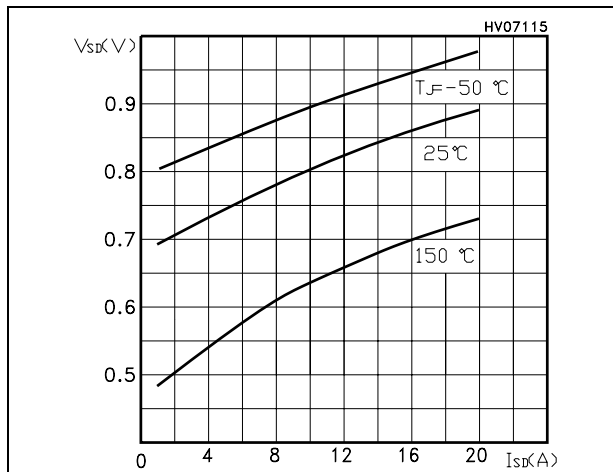


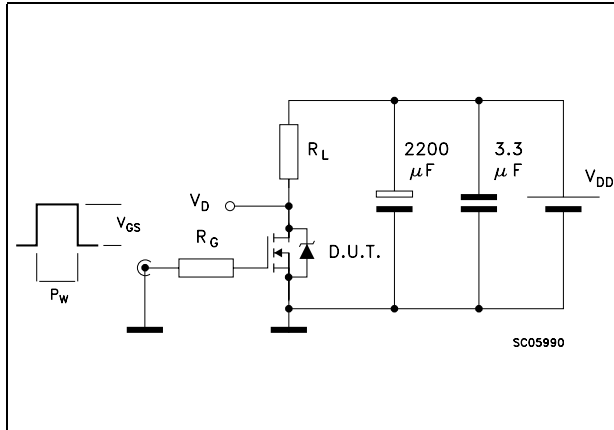
Figure 13. Normalized on resistance vs temperature



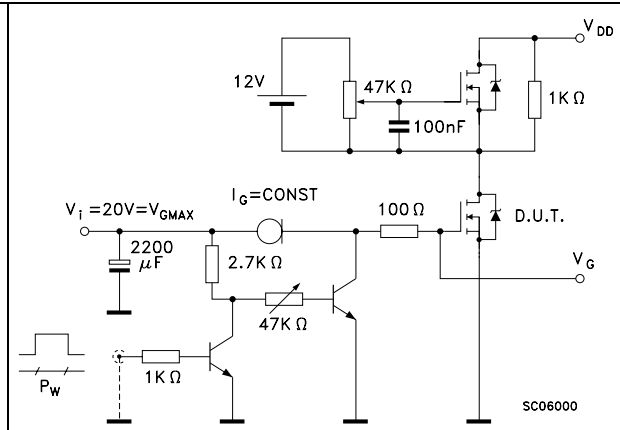
**Figure 14. Source-drain diode forward characteristics**

### 3 Test circuit

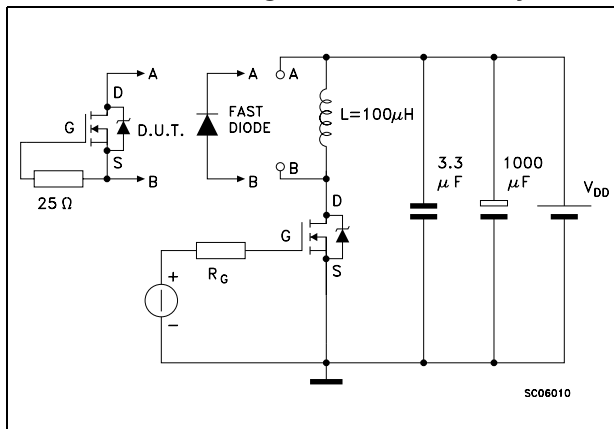
**Figure 15. Switching times test circuit for resistive load**



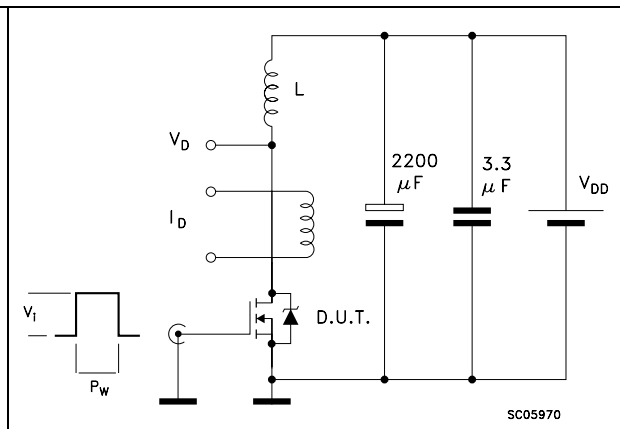
**Figure 16. Gate charge test circuit**



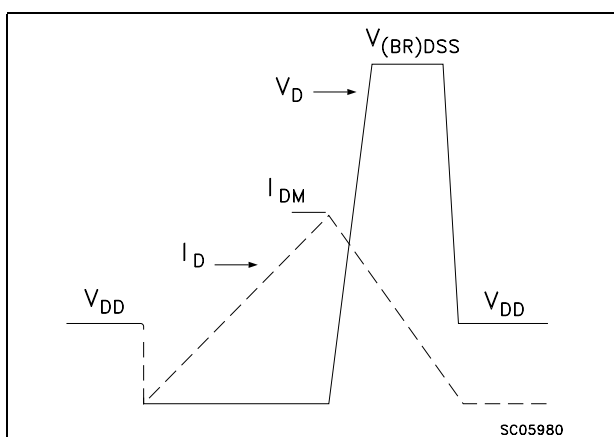
**Figure 17. Test circuit for inductive load switching and diode recovery times**



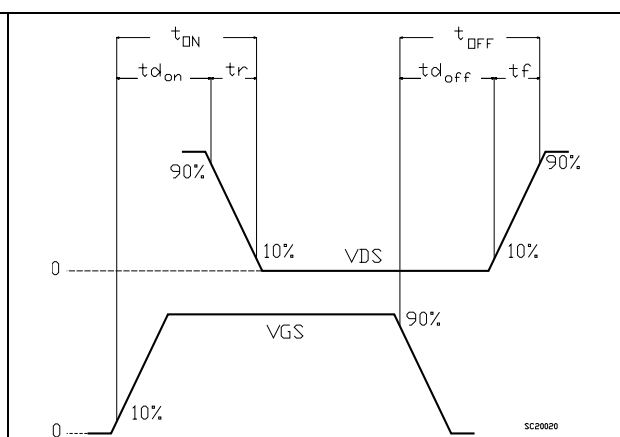
**Figure 18. Unclamped Inductive load test circuit**



**Figure 19. Unclamped inductive waveform**



**Figure 20. Switching time waveform**

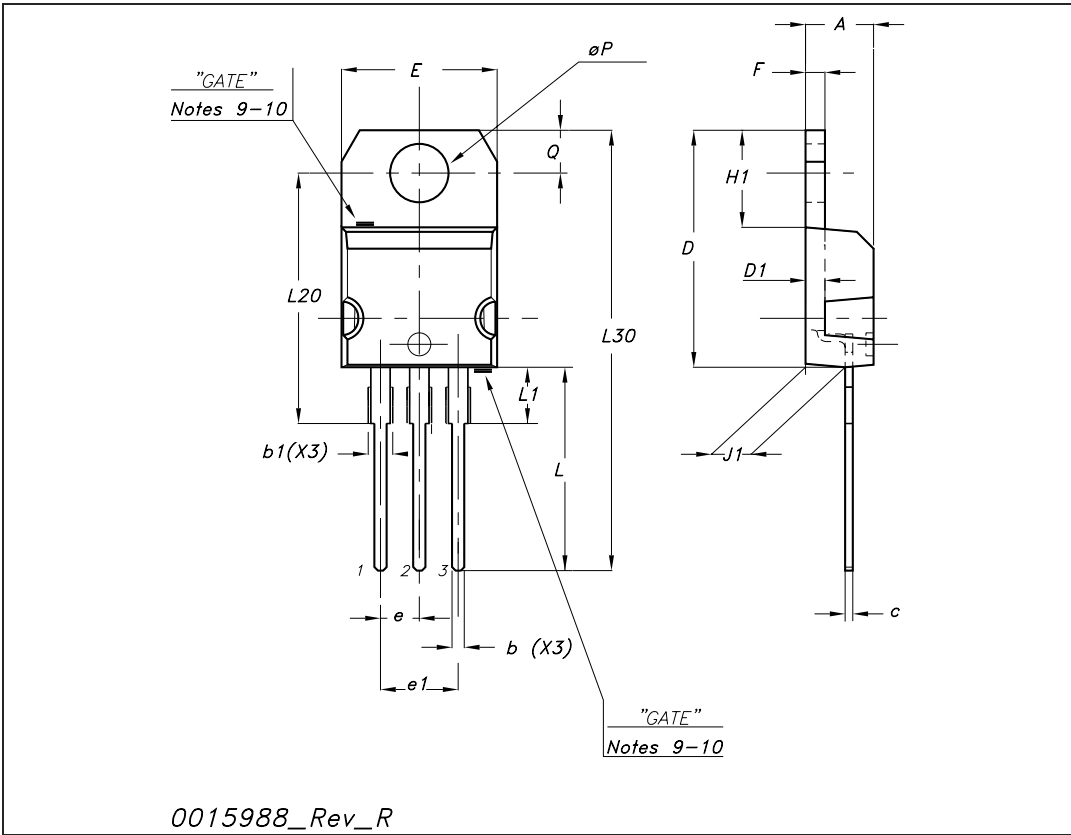


## 4 Package mechanical data

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)

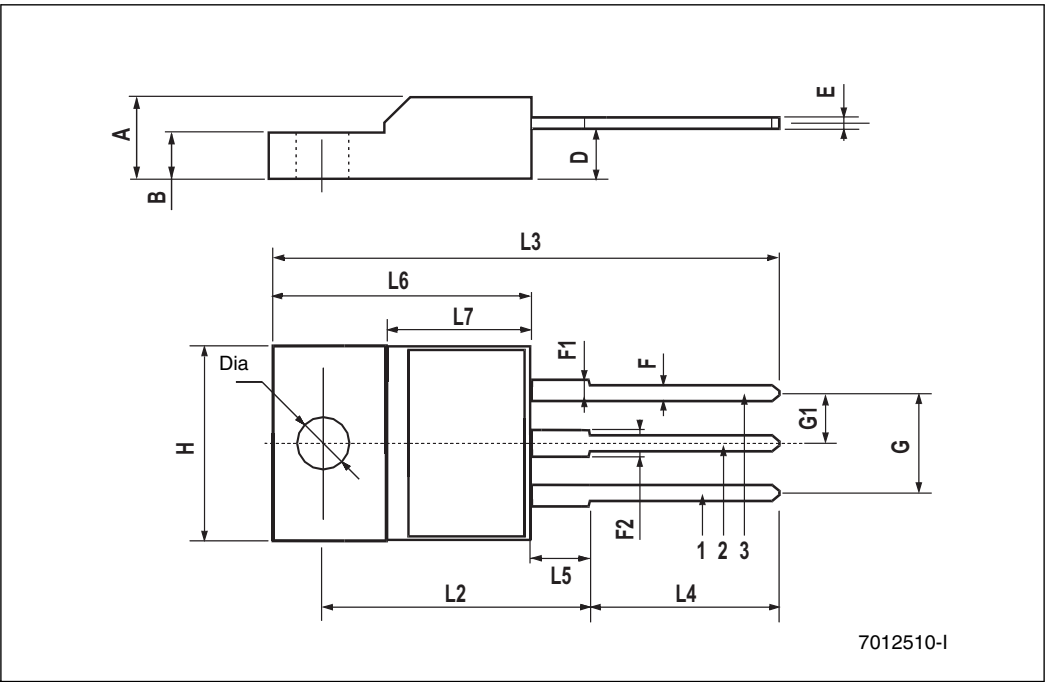
TO-220 mechanical data

| 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   | 0.48  |       | 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 |



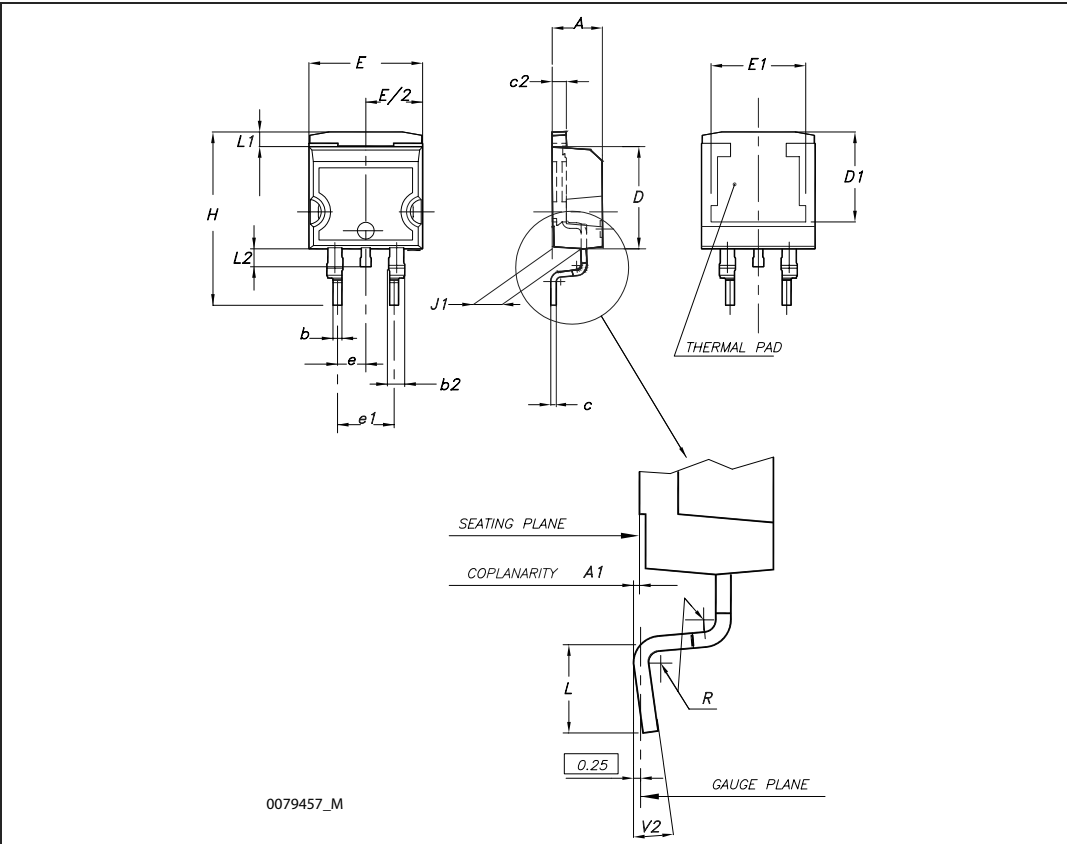
TO-220FP mechanical data

| Dim. | mm.   |     |       | inch  |       |       |
|------|-------|-----|-------|-------|-------|-------|
|      | Min.  | Typ | Max.  | Min.  | Typ.  | Max.  |
| A    | 4.40  |     | 4.60  | 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  |     | 0.70  | 0.017 |       | 0.027 |
| F    | 0.75  |     | 1.00  | 0.030 |       | 0.039 |
| F1   | 1.15  |     | 1.50  | 0.045 |       | 0.067 |
| F2   | 1.15  |     | 1.50  | 0.045 |       | 0.067 |
| G    | 4.95  |     | 5.20  | 0.195 |       | 0.204 |
| G1   | 2.40  |     | 2.70  | 0.094 |       | 0.106 |
| H    | 10    |     | 10.40 | 0.393 |       | 0.409 |
| L2   |       | 16  |       |       | 0.630 |       |
| L3   | 28.6  |     | 30.6  | 1.126 |       | 1.204 |
| L4   | 9.80  |     | 10.60 | 0.385 |       | 0.417 |
| L5   | 2.9   |     | 3.6   | 0.114 |       | 0.141 |
| L6   | 15.90 |     | 16.40 | 0.626 |       | 0.645 |
| L7   | 9     |     | 9.30  | 0.354 |       | 0.366 |
| Dia  | 3     |     | 3.2   | 0.118 |       | 0.126 |



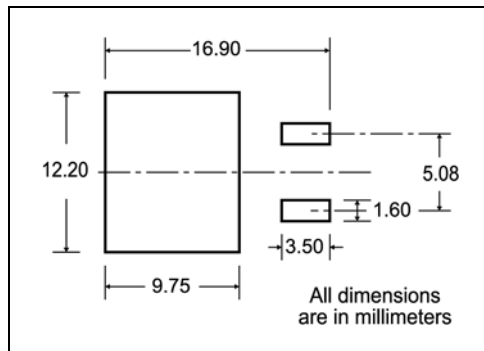
D<sup>2</sup>PAK (TO-263) mechanical data

| Dim | mm   |      |       | inch  |       |       |
|-----|------|------|-------|-------|-------|-------|
|     | Min  | Typ  | Max   | Min   | Typ   | Max   |
| A   | 4.40 |      | 4.60  | 0.173 |       | 0.181 |
| A1  | 0.03 |      | 0.23  | 0.001 |       | 0.009 |
| b   | 0.70 |      | 0.93  | 0.027 |       | 0.037 |
| b2  | 1.14 |      | 1.70  | 0.045 |       | 0.067 |
| c   | 0.45 |      | 0.60  | 0.017 |       | 0.024 |
| c2  | 1.23 |      | 1.36  | 0.048 |       | 0.053 |
| D   | 8.95 |      | 9.35  | 0.352 |       | 0.368 |
| D1  | 7.50 |      |       | 0.295 |       |       |
| E   | 10   |      | 10.40 | 0.394 |       | 0.409 |
| E1  | 8.50 |      |       | 0.334 |       |       |
| e   |      | 2.54 |       |       | 0.1   |       |
| e1  | 4.88 |      | 5.28  | 0.192 |       | 0.208 |
| H   | 15   |      | 15.85 | 0.590 |       | 0.624 |
| J1  | 2.49 |      | 2.69  | 0.099 |       | 0.106 |
| L   | 2.29 |      | 2.79  | 0.090 |       | 0.110 |
| L1  | 1.27 |      | 1.40  | 0.05  |       | 0.055 |
| L2  | 1.30 |      | 1.75  | 0.051 |       | 0.069 |
| R   |      | 0.4  |       |       | 0.016 |       |
| V2  | 0°   |      | 8°    | 0°    |       | 8°    |

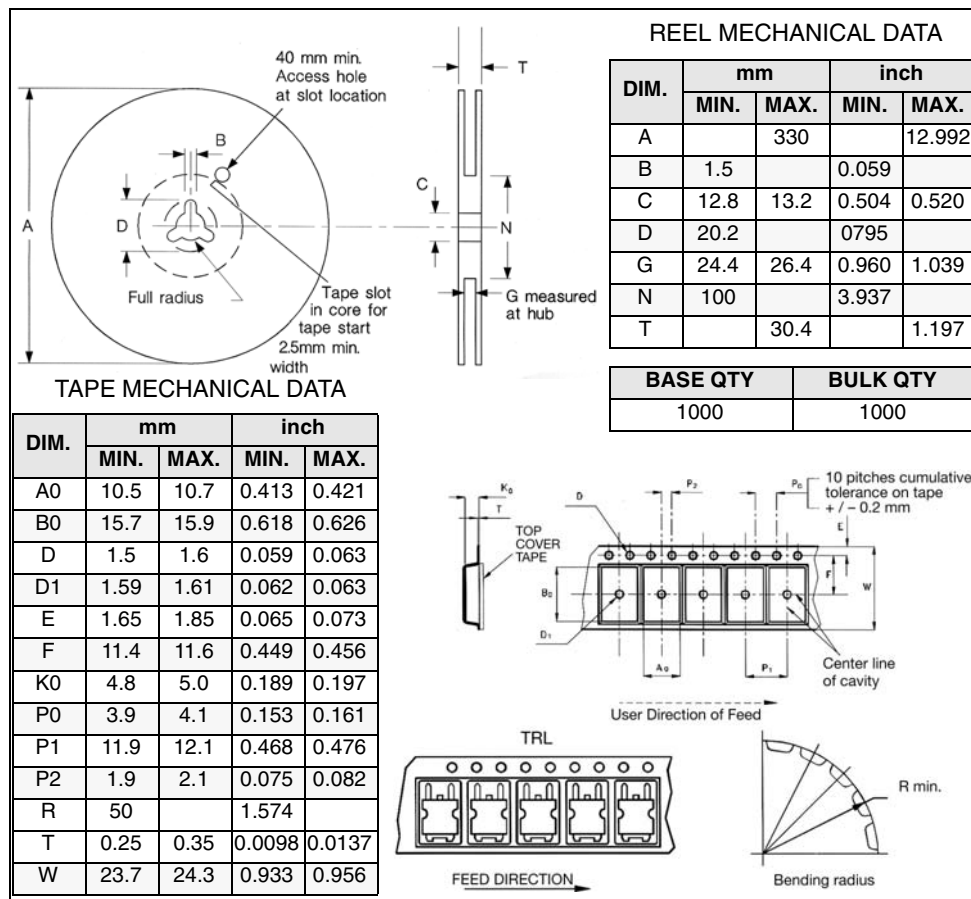


## 5 Packaging mechanical data

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



### TAPE AND REEL SHIPMENT



\* on sales type

## 6 Revision history

Table 9. Document revision history

| Date        | Revision | Changes                                                                                                      |
|-------------|----------|--------------------------------------------------------------------------------------------------------------|
| 21-Jun-2004 | 8        |                                                                                                              |
| 21-Apr-2008 | 9        | <i>Figure 4: Safe operating area for TO-220FP</i> and <i>Figure 5: Thermal impedance for TO-220FP</i> added. |

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- Поставка электронных компонентов под контролем ВП;
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- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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