

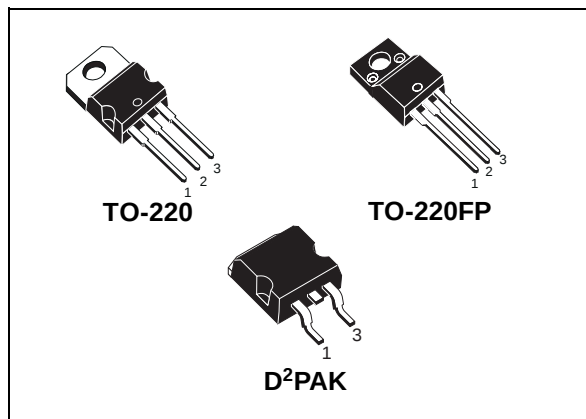


# STP20NM50FD STF20NM50D - STB20NM50FD

N-CHANNEL 500V - 0.22Ω - 20A TO-220/TO-220FP/D<sup>2</sup>PAK  
FDmesh™ Power MOSFET (with FAST DIODE)

| TYPE        | V <sub>DSS</sub> | R <sub>DS(on)</sub> | R <sub>ds(on)</sub> *Q <sub>g</sub> | I <sub>D</sub> |
|-------------|------------------|---------------------|-------------------------------------|----------------|
| STP20NM50FD | 500V             | <0.25Ω              | 8.36 Ω*nC                           | 20 A           |
| STF20NM50D  | 500V             | <0.25Ω              | 8.36 Ω*nC                           | 20 A           |
| STB20NM50FD | 500V             | <0.25Ω              | 8.36 Ω*nC                           | 20 A           |

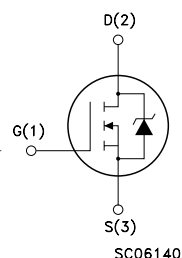
- TYPICAL R<sub>DS(on)</sub> = 0.22Ω
- HIGH dv/dt AND AVALANCHE CAPABILITIES
- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE
- TIGHT PROCESS CONTROL AND HIGH MANUFACTURING YIELDS



## 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.

## INTERNAL SCHEMATIC DIAGRAM



## APPLICATIONS

- ZVS PHASE-SHIFT FULL BRIDGE CONVERTERS FOR SMPS AND WELDING EQUIPMENT

## ORDERING INFORMATION

| SALES TYPE  | MARKING   | PACKAGE            | PACKAGING   |
|-------------|-----------|--------------------|-------------|
| STP20NM50FD | P20NM50FD | TO-220             | TUBE        |
| STF20NM50D  | F20NM50D  | TO-220FP           | TUBE        |
| STB20NM50FD | B20NM50FD | D <sup>2</sup> PAK | TAPE & REEL |

## STP20NM50FD - STF20NM50D - STB20NM50FD

### ABSOLUTE MAXIMUM RATINGS

| Symbol            | Parameter                                               | Value                      |            | Unit                |
|-------------------|---------------------------------------------------------|----------------------------|------------|---------------------|
|                   |                                                         | STP20NM50FD<br>STB20NM50FD | STF20NM50D |                     |
| $V_{DS}$          | Drain-source Voltage ( $V_{GS} = 0$ )                   | 500                        |            | V                   |
| $V_{DGR}$         | Drain-gate Voltage ( $R_{GS} = 20\text{ k}\Omega$ )     | 500                        |            | V                   |
| $V_{GS}$          | Gate- source Voltage                                    | $\pm 30$                   |            | V                   |
| $I_D$             | Drain Current (continuous) at $T_C = 25^\circ\text{C}$  | 20                         | 20 (*)     | A                   |
| $I_D$             | Drain Current (continuous) at $T_C = 100^\circ\text{C}$ | 14                         | 14 (*)     | A                   |
| $I_{DM}(\bullet)$ | Drain Current (pulsed)                                  | 80                         | 80 (*)     | A                   |
| $P_{TOT}$         | Total Dissipation at $T_C = 25^\circ\text{C}$           | 192                        | 45         | W                   |
|                   | Derating Factor                                         | 1.2                        | 0.36       | W/ $^\circ\text{C}$ |
| dv/dt (1)         | Peak Diode Recovery voltage slope                       | 20                         |            | V/ns                |
| $V_{ISO}$         | Insulation Withstand Voltage (DC)                       | --                         | 2000       | V                   |
| $T_{stg}$         | Storage Temperature                                     | -65 to 150                 |            | $^\circ\text{C}$    |
| $T_j$             | Max. Operating Junction Temperature                     | 150                        |            | $^\circ\text{C}$    |

(●) Pulse width limited by safe operating area

(1)  $I_{SD} \leq 20\text{A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

(\*) Limited only by maximum temperature allowed

### THERMAL DATA

|                       |                                                | TO-220 / D <sup>2</sup> PAK | TO-220FP |                           |
|-----------------------|------------------------------------------------|-----------------------------|----------|---------------------------|
| R <sub>thj-case</sub> | Thermal Resistance Junction-case Max           | 0.65                        | 2.8      | $^\circ\text{C}/\text{W}$ |
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient Max        | 62.5                        |          | $^\circ\text{C}/\text{W}$ |
| $T_l$                 | Maximum Lead Temperature For Soldering Purpose | 300                         |          | $^\circ\text{C}$          |

### AVALANCHE CHARACTERISTICS

| Symbol   | Parameter                                                                                                    | Max Value | Unit |
|----------|--------------------------------------------------------------------------------------------------------------|-----------|------|
| $I_{AR}$ | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max)                           | 10        | A    |
| $E_{AS}$ | Single Pulse Avalanche Energy (starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 35\text{ V}$ ) | 700       | mJ   |

### ELECTRICAL CHARACTERISTICS (TCASE = 25 °C UNLESS OTHERWISE SPECIFIED) ON/OFF

| Symbol        | Parameter                                        | Test Conditions                                                                          | Min. | Typ. | Max.      | Unit                           |
|---------------|--------------------------------------------------|------------------------------------------------------------------------------------------|------|------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage                   | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0$                                            | 500  |      |           | V                              |
| $I_{DSS}$     | Zero Gate Voltage Drain Current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating}$ , $T_C = 125^\circ\text{C}$ |      |      | 1<br>10   | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body Leakage Current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 30\text{V}$                                                                |      |      | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate Threshold Voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                       | 3    | 4    | 5         | V                              |
| $R_{DS(on)}$  | Static Drain-source On Resistance                | $V_{GS} = 10\text{V}$ , $I_D = 10\text{A}$                                               |      | 0.22 | 0.25      | $\Omega$                       |

**ELECTRICAL CHARACTERISTICS (CONTINUED)**

**DYNAMIC**

| Symbol                              | Parameter                                                               | Test Conditions                                                         | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|------|-------------------|------|----------------|
| $g_{fs}$ (1)                        | Forward Transconductance                                                | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ ,<br>$I_D = 10A$              |      | 9                 |      | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input Capacitance<br>Output Capacitance<br>Reverse Transfer Capacitance | $V_{DS} = 25V$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$                      |      | 1380<br>290<br>40 |      | pF<br>pF<br>pF |
| $C_{oss\text{ eq.}}$ (2)            | Equivalent Output Capacitance                                           | $V_{GS} = 0V$ , $V_{DS} = 0V$ to $400V$                                 |      | 130               |      | pF             |
| $R_g$                               | Gate Input Resistance                                                   | $f=1\text{ MHz}$ Gate DC Bias=0<br>Test Signal Level=20mV<br>Open Drain |      | 2.8               |      | $\Omega$       |

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

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

**SWITCHING ON**

| Symbol                        | Parameter                                                    | Test Conditions                                                                                             | Min. | Typ.           | Max. | Unit           |
|-------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|------|----------------|------|----------------|
| $t_{d(on)}$<br>$t_r$          | Turn-on Delay Time<br>Rise Time                              | $V_{DD} = 250V$ , $I_D = 10\text{ A}$<br>$R_G = 4.7\Omega$ , $V_{GS} = 10V$<br>(see test circuit, Figure 3) |      | 22<br>20       |      | ns<br>ns       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge | $V_{DD} = 400V$ , $I_D = 20A$ ,<br>$V_{GS} = 10V$                                                           |      | 38<br>18<br>10 | 53   | nC<br>nC<br>nC |

**SWITCHING OFF**

| Symbol                          | Parameter                                             | Test Conditions                                                                                               | Min. | Typ.          | Max. | Unit           |
|---------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------|---------------|------|----------------|
| $t_{r(Voff)}$<br>$t_f$<br>$t_c$ | Off-voltage Rise Time<br>Fall Time<br>Cross-over Time | $V_{DD} = 400V$ , $I_D = 20\text{ A}$ ,<br>$R_G = 4.7\Omega$ , $V_{GS} = 10V$<br>(see test circuit, Figure 5) |      | 6<br>15<br>30 |      | ns<br>ns<br>ns |

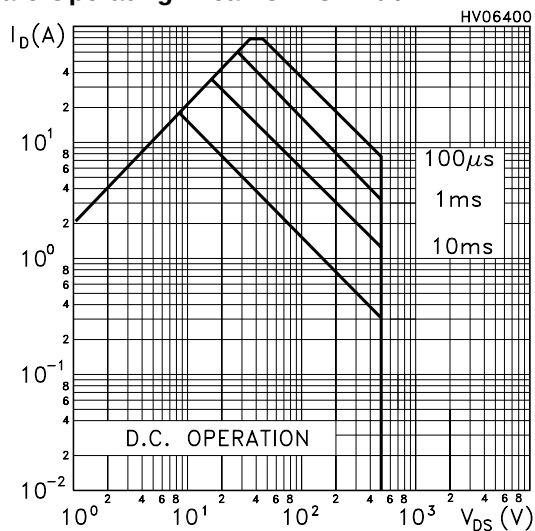
**SOURCE DRAIN DIODE**

| 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                                                           | $I_{SD} = 20\text{ A}$ , $V_{GS} = 0$                                                                                   |      |                | 1.5      | V                  |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD} = 20\text{ A}$ , $di/dt = 100A/\mu s$ ,<br>$V_{DD} = 60V$ , $T_j = 150^\circ C$<br>(see test circuit, Figure 5) |      | 245<br>2<br>16 |          | ns<br>$\mu C$<br>A |

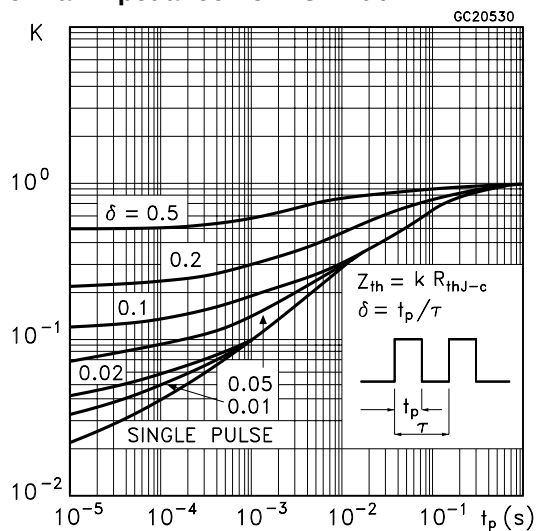
Note: 1. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %.

2. Pulse width limited by safe operating area.

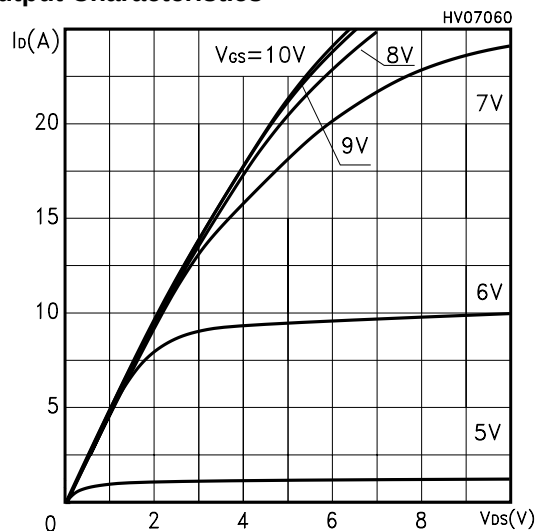
Safe Operating Area For TO-220 / I<sup>2</sup>PAK



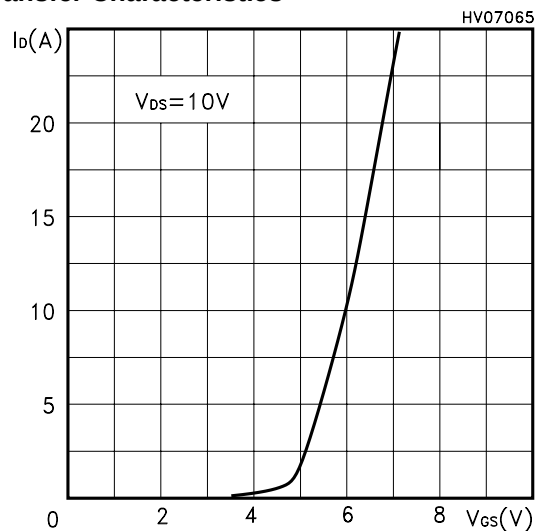
Thermal Impedance For TO-220 / I<sup>2</sup>PAK



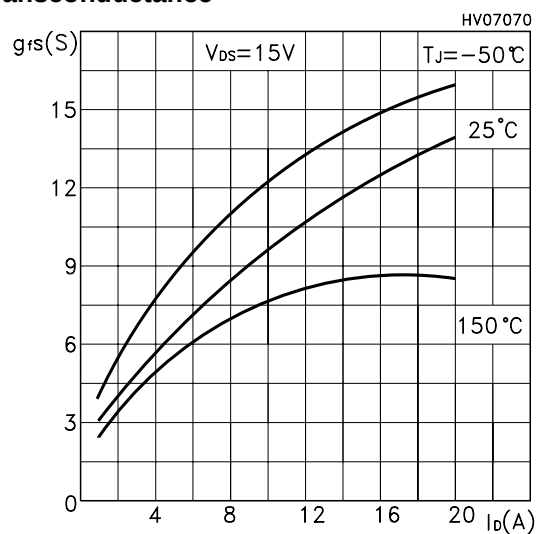
Output Characteristics



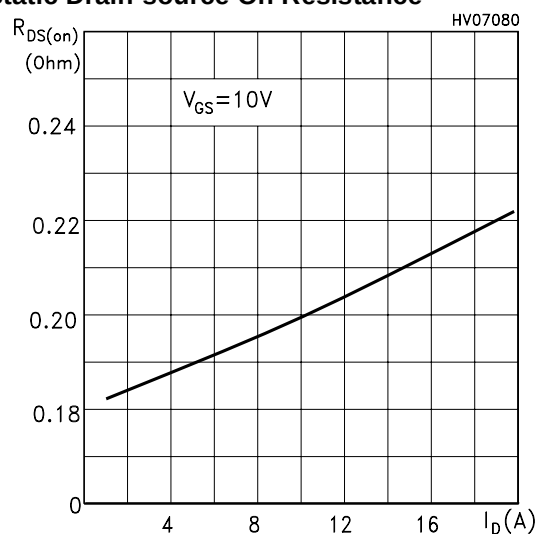
Transfer Characteristics



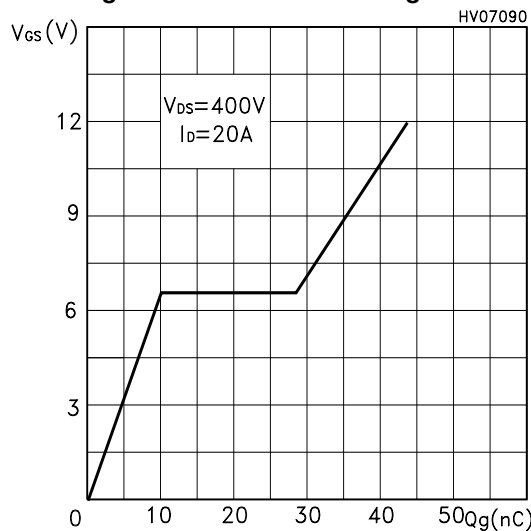
Transconductance



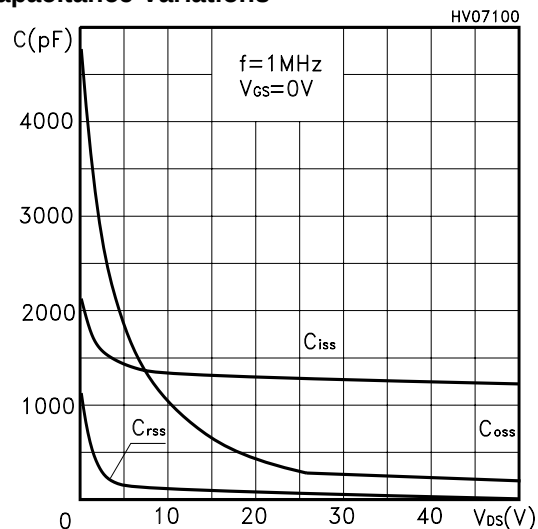
Static Drain-source On Resistance



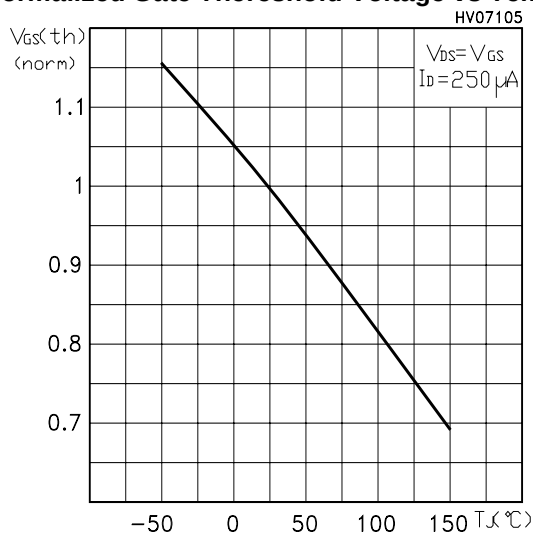
Gate Charge vs Gate-source Voltage



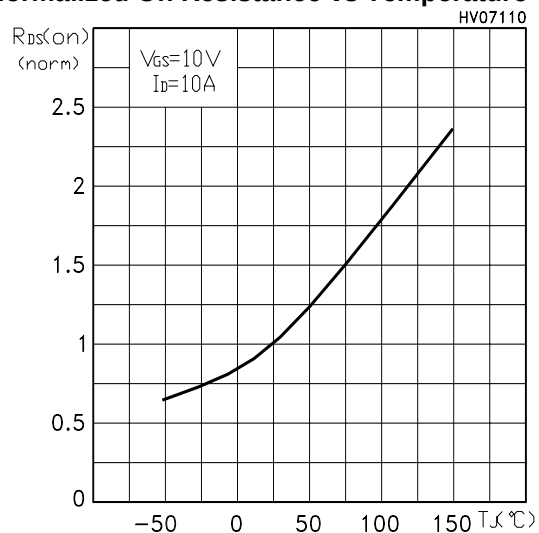
Capacitance Variations



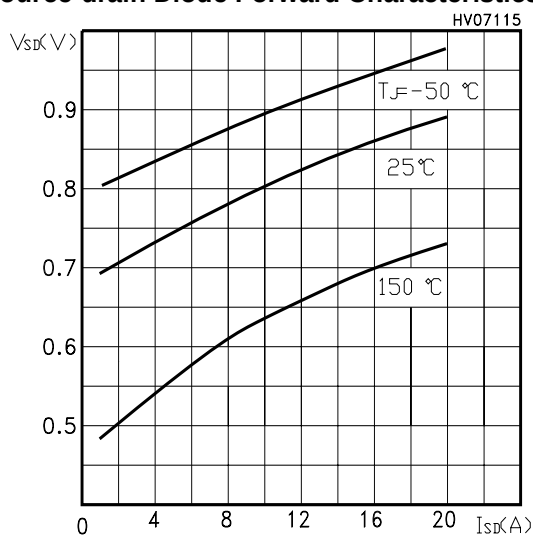
Normalized Gate Threshold Voltage vs Temp.



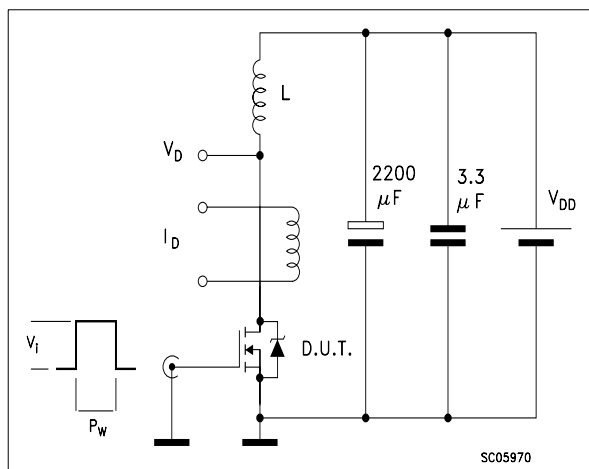
Normalized On Resistance vs Temperature



Source-drain Diode Forward Characteristics



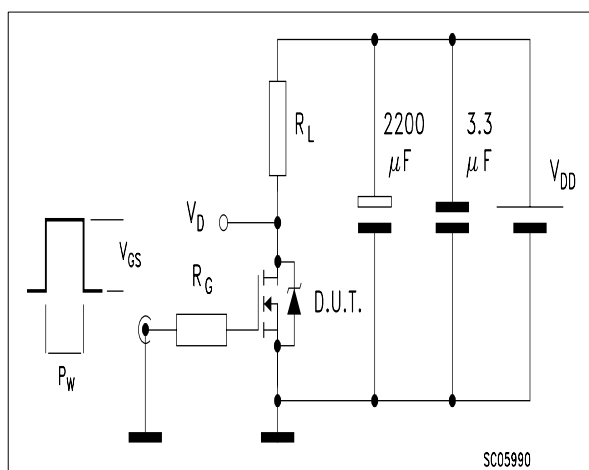
**Fig. 1: Unclamped Inductive Load Test Circuit**



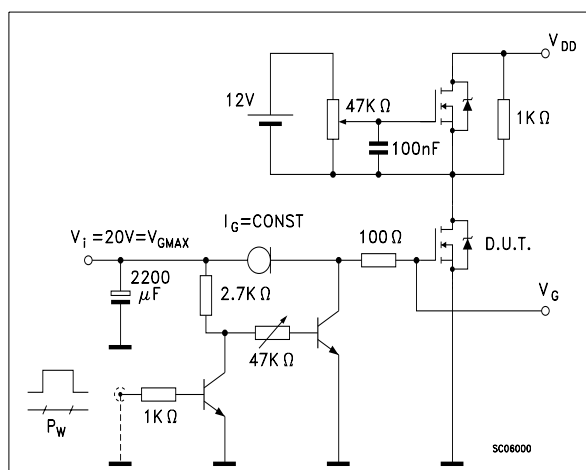
**Fig. 2: Unclamped Inductive Waveform**



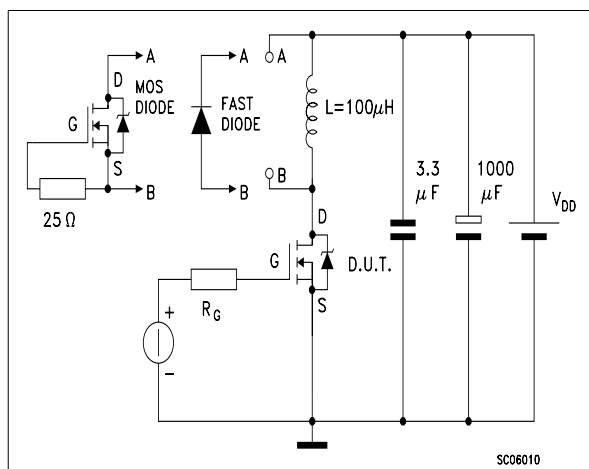
**Fig. 3: Switching Times Test Circuit For Resistive Load**



**Fig. 4: Gate Charge test Circuit**

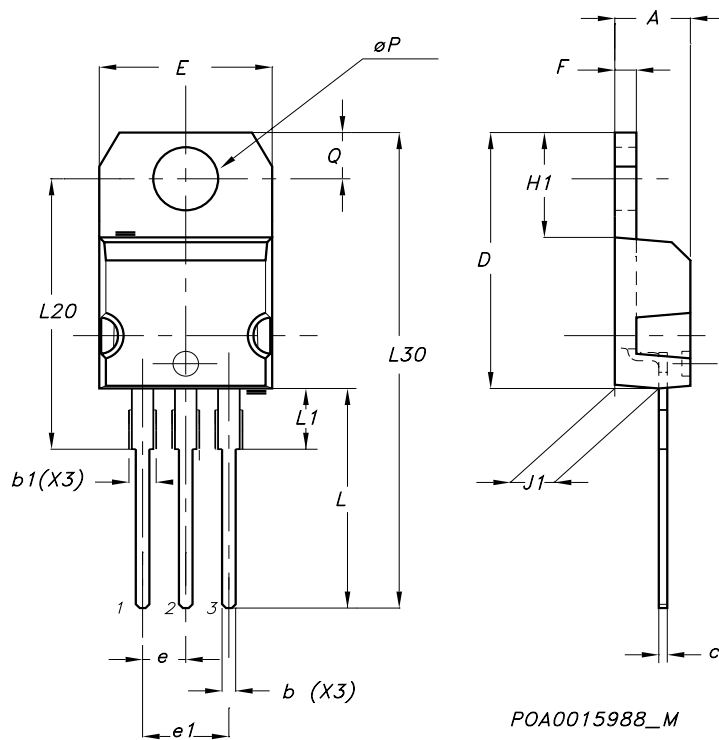


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



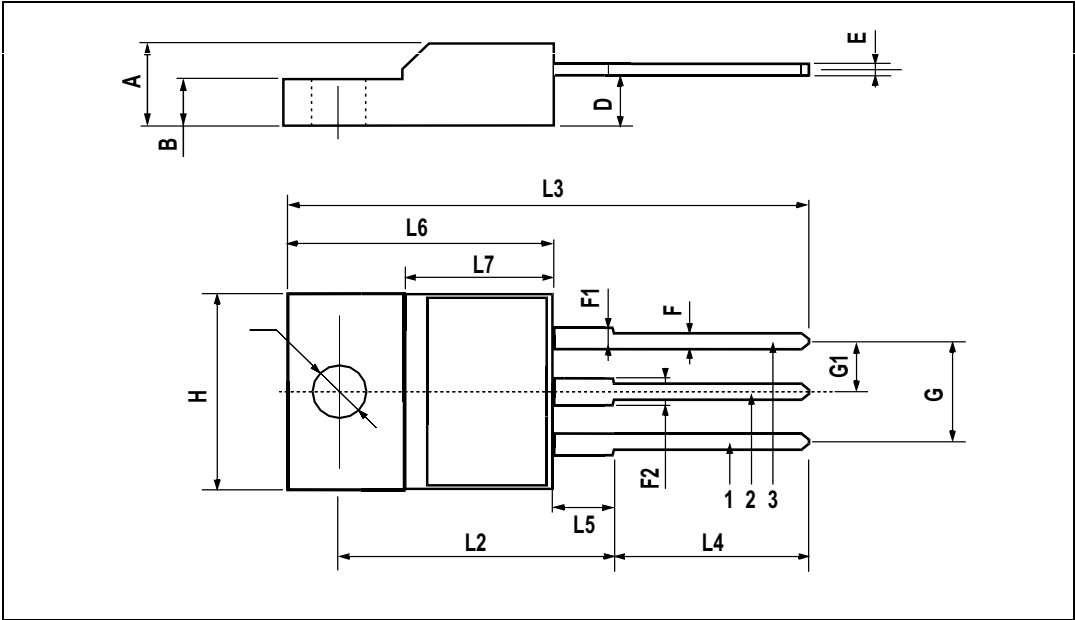
## TO-220 MECHANICAL DATA

| 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 |



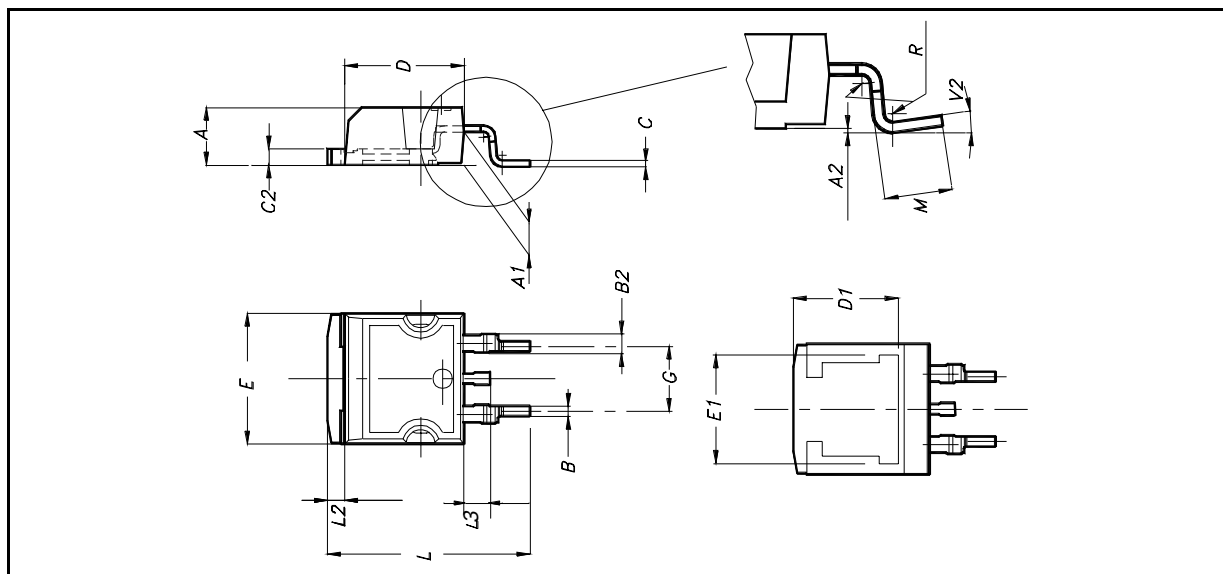
TO-220FP MECHANICAL DATA

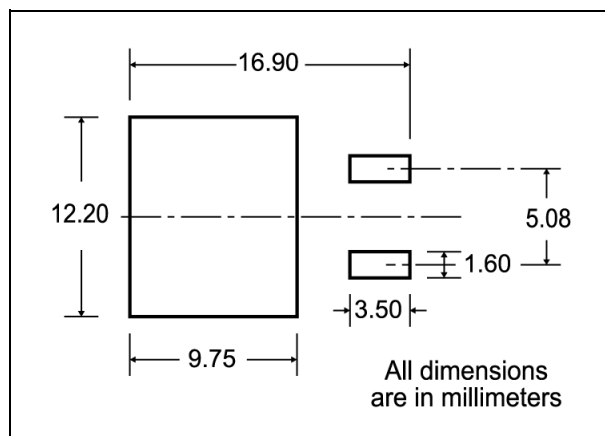
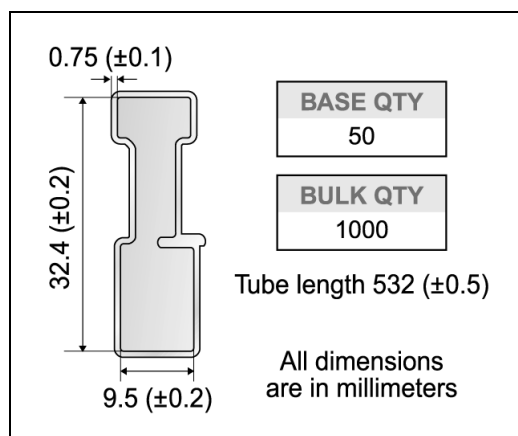
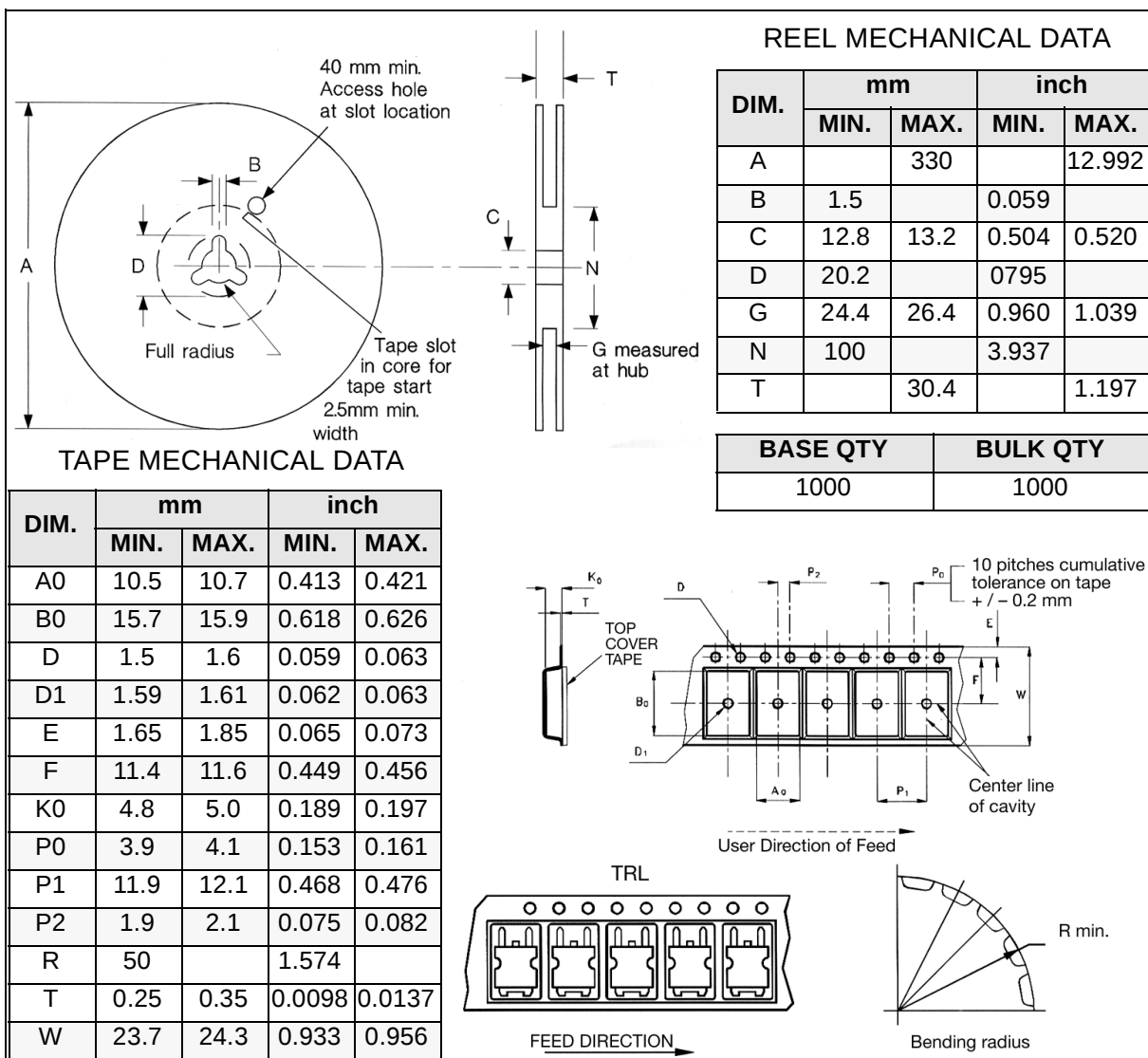
| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |      | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |      | 2.75 | 0.098 |       | 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 |



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°    |       |       |       |



**D<sup>2</sup>PAK FOOTPRINT****TUBE SHIPMENT (no suffix)\*****TAPE AND REEL SHIPMENT (suffix "T4")\***

\* on sales type  
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