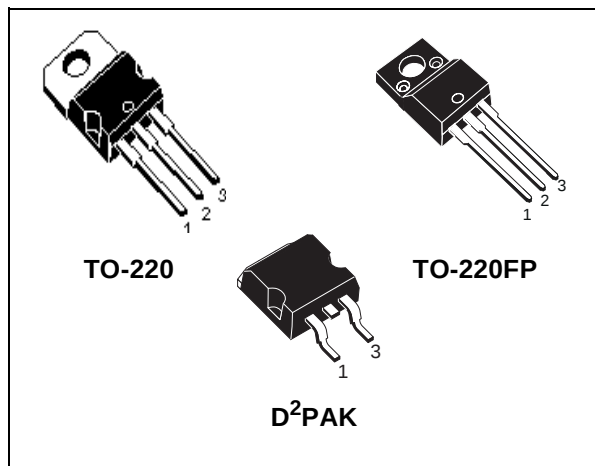


## N-CHANNEL 500V - 0.48Ω - 10A TO-220/TO-220FP/D<sup>2</sup>PAK Zener-Protected SuperMESH™ Power MOSFET

| TYPE         | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>w</sub> |
|--------------|------------------|---------------------|----------------|----------------|
| STB11NK50Z   | 500 V            | < 0.52 Ω            | 10 A           | 125 W          |
| STP11NK50Z   | 500 V            | < 0.52 Ω            | 10 A           | 125 W          |
| STP11NK50ZFP | 500 V            | < 0.52 Ω            | 10 A           | 30 W           |

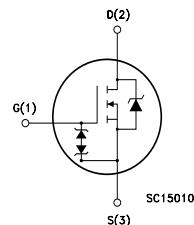
- TYPICAL R<sub>DS(on)</sub> = 0.48 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- 100% AVALANCHE TESTED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY
- ADD SUFFIX "T4" FOR ORDERING IN TAPE & REEL (D<sup>2</sup>PAK VERSION)



### DESCRIPTION

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements ST full range of high voltage MOSFETs including revolutionary MDmesh™ products.

### INTERNAL SCHEMATIC DIAGRAM



### APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES, ADAPTORS AND PFC
- LIGHTING

### ORDERING INFORMATION

| SALES TYPE   | MARKING    | PACKAGE            | PACKAGING   |
|--------------|------------|--------------------|-------------|
| STB11NK50ZT4 | B11NK50Z   | D <sup>2</sup> PAK | TAPE & REEL |
| STP11NK50Z   | P11NK50Z   | TO-220             | TUBE        |
| STP11NK50ZFP | P11NK50ZFP | TO-220FP           | TUBE        |

**ABSOLUTE MAXIMUM RATINGS**

| Symbol                             | Parameter                                             | Value                       |          | Unit     |
|------------------------------------|-------------------------------------------------------|-----------------------------|----------|----------|
|                                    |                                                       | TO-220 / D <sup>2</sup> PAK | 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                                  | ± 30                        |          | V        |
| I <sub>D</sub>                     | Drain Current (continuous) at T <sub>C</sub> = 25°C   | 10                          | 10(*)    | A        |
| I <sub>D</sub>                     | Drain Current (continuous) at T <sub>C</sub> = 100°C  | 6.3                         | 6.3(*)   | A        |
| I <sub>DM</sub> (•)                | Drain Current (pulsed)                                | 40                          | 40(*)    | A        |
| P <sub>TOT</sub>                   | Total Dissipation at T <sub>C</sub> = 25°C            | 125                         | 30       | W        |
|                                    | Derating Factor                                       | 1                           | 0.24     | W/°C     |
| V <sub>ESD(G-S)</sub>              | Gate source ESD(HBM-C=100pF, R=1.5KΩ)                 | 4000                        |          | V        |
| dv/dt (1)                          | Peak Diode Recovery voltage slope                     | 4.5                         |          | V/ns     |
| V <sub>iso</sub>                   | Insulation Withstand Voltage (DC)                     | --                          | 2500     | V        |
| T <sub>j</sub><br>T <sub>stg</sub> | Operating Junction Temperature<br>Storage Temperature | -55 to 150<br>-55 to 150    |          | °C<br>°C |

(•) Pulse width limited by safe operating area

(1) I<sub>SD</sub> ≤ 10A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>.

(\*) 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           | 1                           | 4.2      | °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   |

**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)                                | 10        | 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) | 190       | mJ   |

**GATE-SOURCE ZENER DIODE**

| Symbol            | Parameter                     | Test Conditions                     | Min. | Typ. | Max. | Unit |
|-------------------|-------------------------------|-------------------------------------|------|------|------|------|
| BV <sub>GSO</sub> | Gate-Source Breakdown Voltage | I <sub>gs</sub> =± 1mA (Open Drain) | 30   |      |      | V    |

**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                   | $I_D = 1mA, V_{GS} = 0$                                                         | 500  |      |          | V                  |
| $I_{DSS}$     | Zero Gate Voltage Drain Current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating}, T_C = 125^\circ C$ |      |      | 1<br>50  | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate-body Leakage Current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20V$                                                              |      |      | $\pm 10$ | $\mu A$            |
| $V_{GS(th)}$  | Gate Threshold Voltage                           | $V_{DS} = V_{GS}, I_D = 100\mu A$                                               | 3    | 3.75 | 4.5      | V                  |
| $R_{DS(on)}$  | Static Drain-source On Resistance                | $V_{GS} = 10V, I_D = 5 A$                                                       |      | 0.48 | 0.52     | $\Omega$           |

**DYNAMIC**

| Symbol                              | Parameter                                                               | Test Conditions                             | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|---------------------------------------------|------|-------------------|------|----------------|
| $g_{fs} (1)$                        | Forward Transconductance                                                | $V_{DS} = 15V, I_D = 5 A$                   |      | 7.7               |      | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input Capacitance<br>Output Capacitance<br>Reverse Transfer Capacitance | $V_{DS} = 25V, f = 1 MHz, V_{GS} = 0$       |      | 1390<br>173<br>42 |      | pF<br>pF<br>pF |
| $C_{oss \text{ eq. (3)}}$           | Equivalent Output Capacitance                                           | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 400V$ |      | 110               |      | pF             |

**SWITCHING ON**

| Symbol                        | Parameter                                                    | Test Conditions                                                                                     | Min. | Typ.           | Max. | Unit           |
|-------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------|----------------|------|----------------|
| $t_{d(on)}$<br>$t_r$          | Turn-on Delay Time<br>Rise Time                              | $V_{DD} = 250 V, I_D = 5.5 A$<br>$R_G = 4.7\Omega, V_{GS} = 10 V$<br>(Resistive Load see, Figure 3) |      | 14.5<br>18     |      | ns<br>ns       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge | $V_{DD} = 400V, I_D = 11.4 A,$<br>$V_{GS} = 10V$                                                    |      | 49<br>10<br>25 | 68   | nC<br>nC<br>nC |

**SWITCHING OFF**

| Symbol                           | Parameter                                             | Test Conditions                                                                                     | Min. | Typ.             | Max. | Unit           |
|----------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------|------------------|------|----------------|
| $t_{d(off)}$<br>$t_f$            | Turn-off Delay Time<br>Fall Time                      | $V_{DD} = 250 V, I_D = 5.5 A$<br>$R_G = 4.7\Omega, V_{GS} = 10 V$<br>(Resistive Load see, Figure 3) |      | 41<br>15         |      | ns<br>ns       |
| $t_r(V_{off})$<br>$t_f$<br>$t_c$ | Off-voltage Rise Time<br>Fall Time<br>Cross-over Time | $V_{DD} = 400V, I_D = 11.4 A,$<br>$R_G = 4.7\Omega, V_{GS} = 10V$<br>(Inductive Load see, Figure 5) |      | 11.5<br>12<br>27 |      | ns<br>ns<br>ns |

**SOURCE DRAIN DIODE**

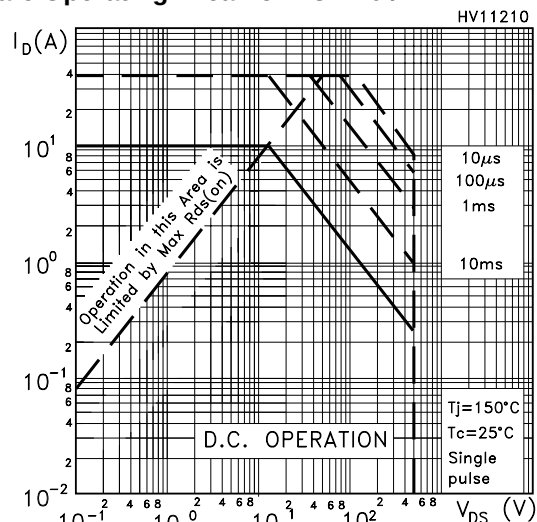
| Symbol                            | Parameter                                                                    | Test Conditions                                                                                          | Min. | Typ.             | Max.     | Unit          |
|-----------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------|------------------|----------|---------------|
| $I_{SD}$<br>$I_{SDM} (2)$         | Source-drain Current<br>Source-drain Current (pulsed)                        |                                                                                                          |      |                  | 10<br>40 | A<br>A        |
| $V_{SD} (1)$                      | Forward On Voltage                                                           | $I_{SD} = 10 A, V_{GS} = 0$                                                                              |      |                  | 1.6      | V             |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD} = 10 A, di/dt = 100A/\mu s$<br>$V_{DD} = 36V, T_J = 150^\circ C$<br>(see test circuit, Figure 5) |      | 308<br>2.4<br>16 |          | ns<br>nC<br>A |

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

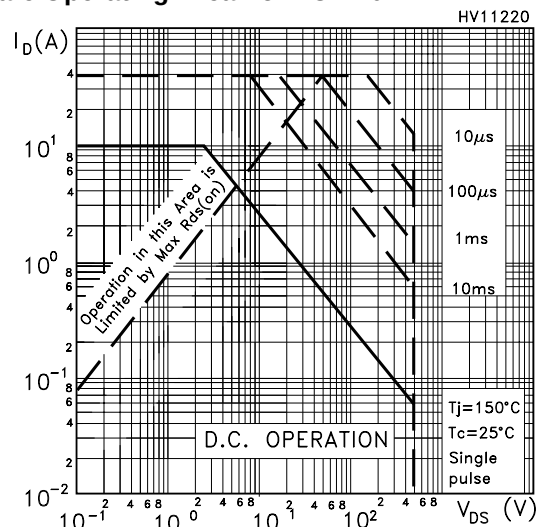
2. Pulse width limited by safe operating area.

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

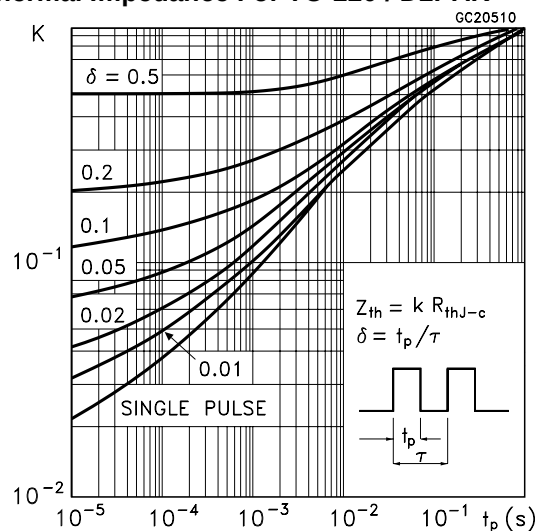
### Safe Operating Area For TO-220 / D2PAK



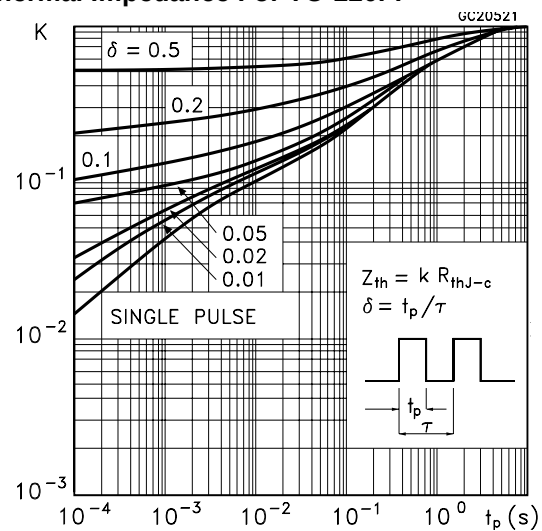
### Safe Operating Area For TO-220FP



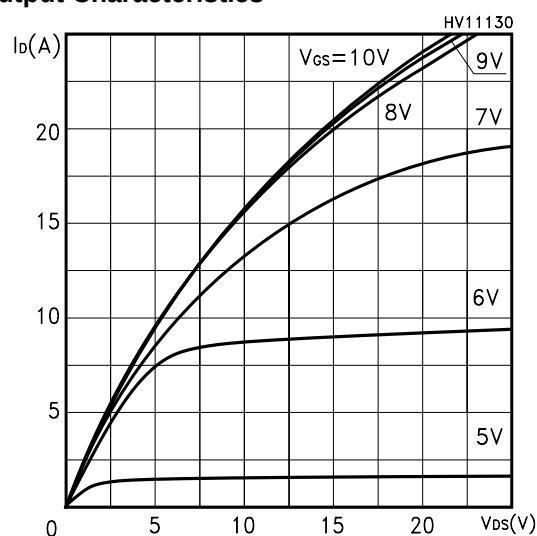
### Thermal Impedance For TO-220 / D2PAK



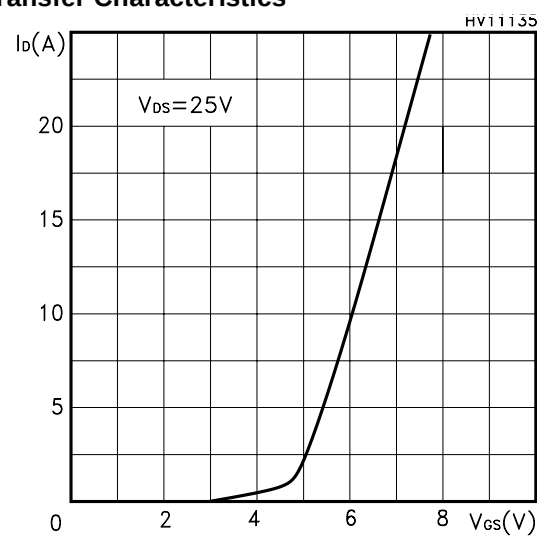
### Thermal Impedance For TO-220FP



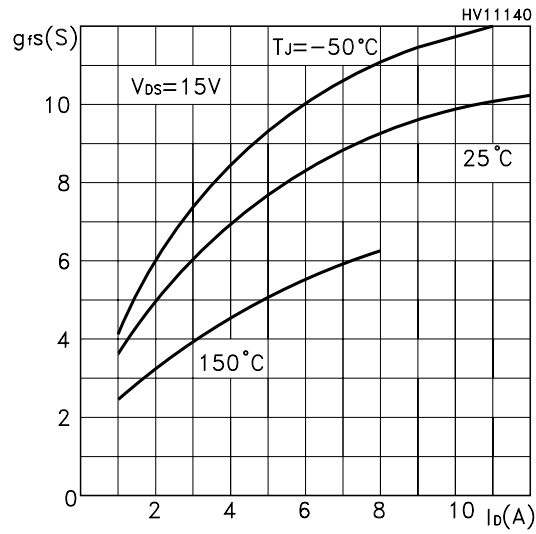
### Output Characteristics



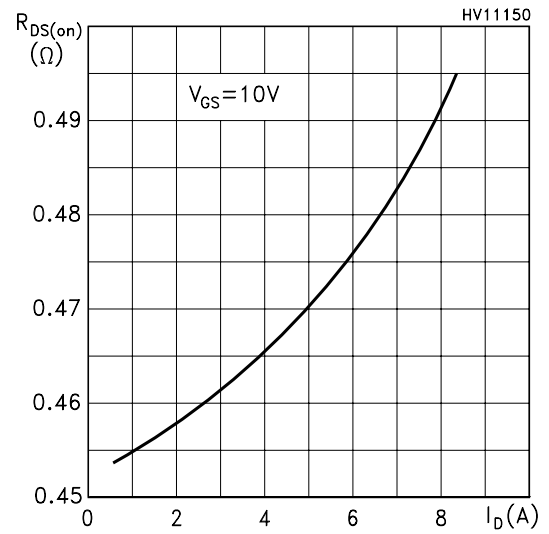
### Transfer Characteristics



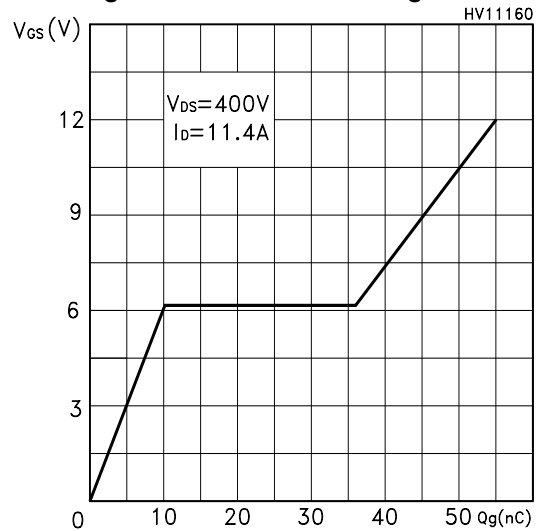
### Transconductance



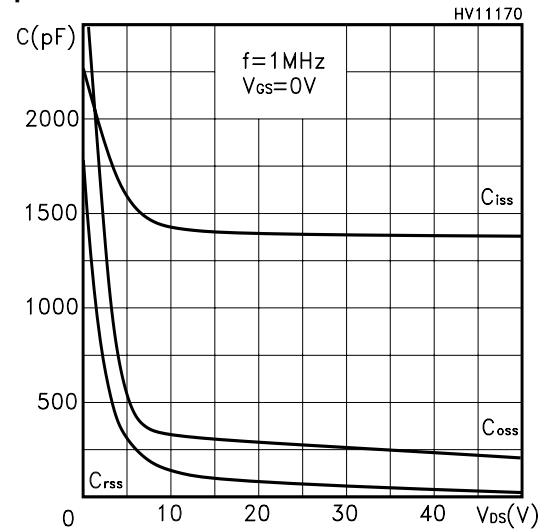
### Static Drain-source On Resistance



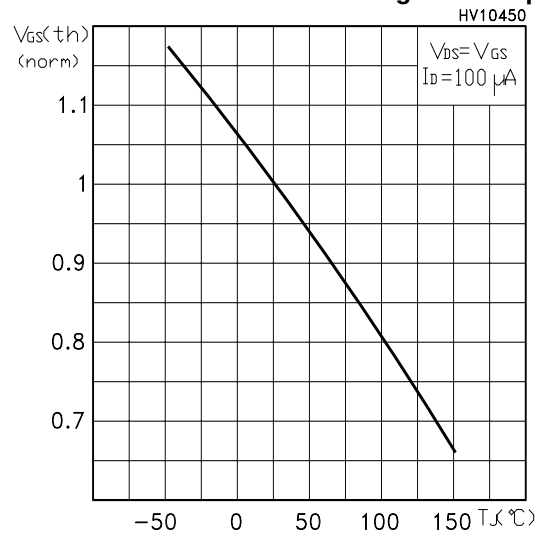
### Gate Charge vs Gate-source Voltage



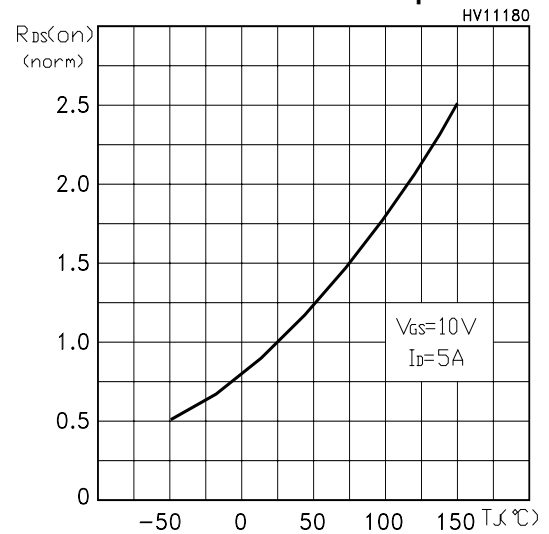
### Capacitance Variations



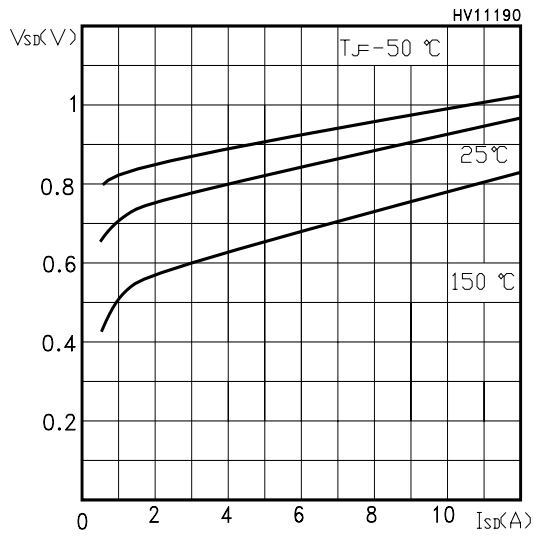
### Normalized Gate Threshold Voltage vs Temp.



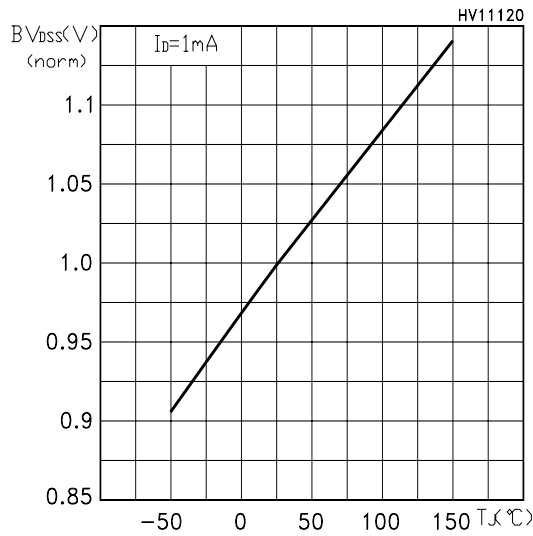
### Normalized On Resistance vs Temperature



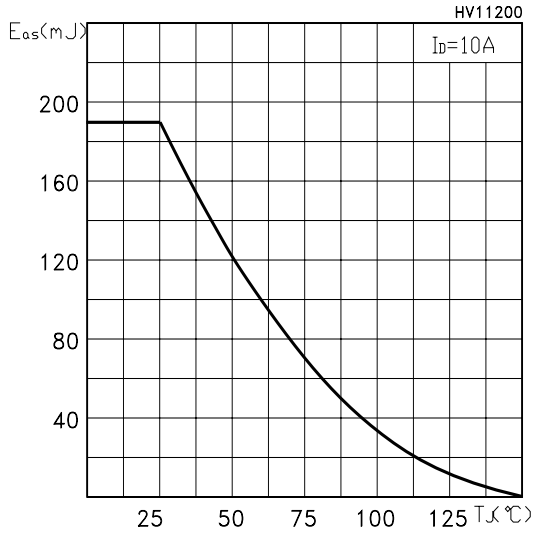
Source-drain Diode Forward Characteristics



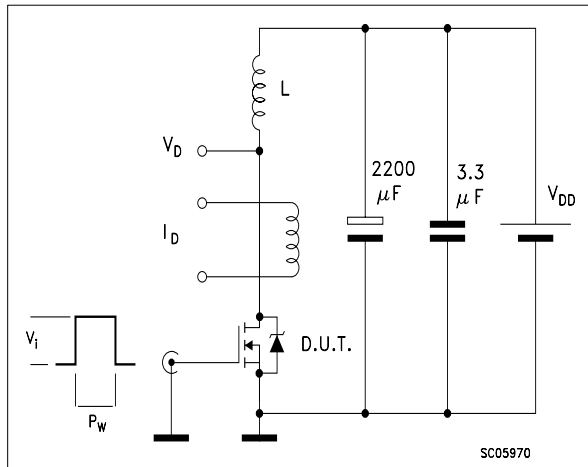
Normalized BVDSS vs Temperature



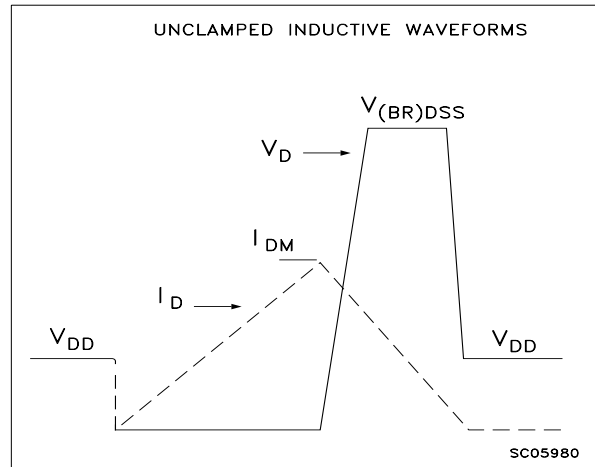
Maximum Avalanche Energy vs Temperature



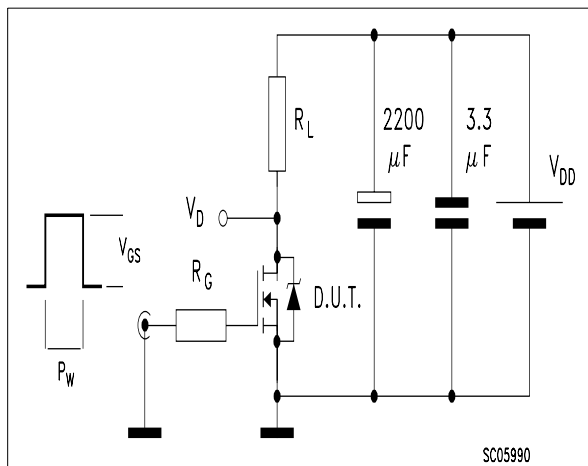
**Fig. 1: Unclamped Inductive Load Test Circuit**



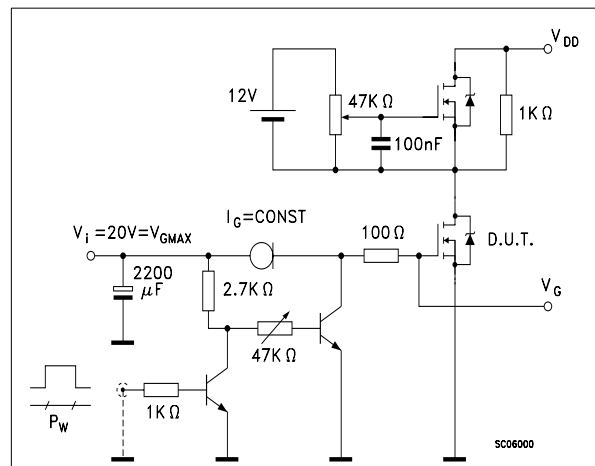
**Fig. 2: Unclamped Inductive Waveform**



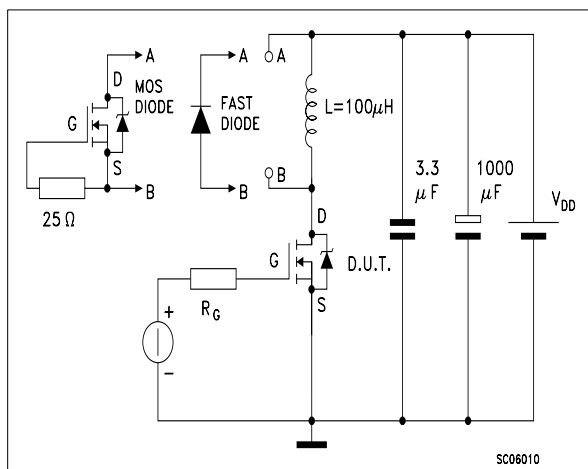
**Fig. 3: Switching Times Test Circuit For Resistive Load**



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

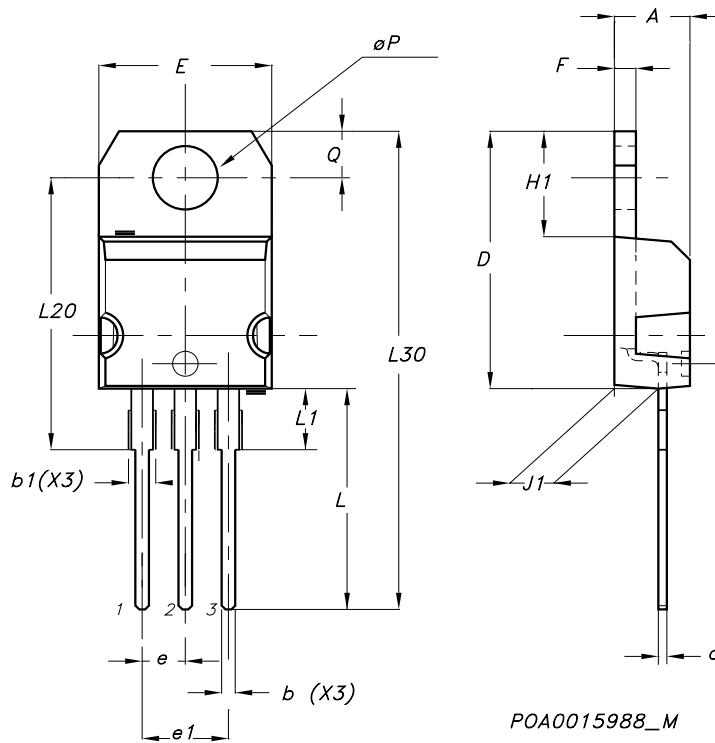


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



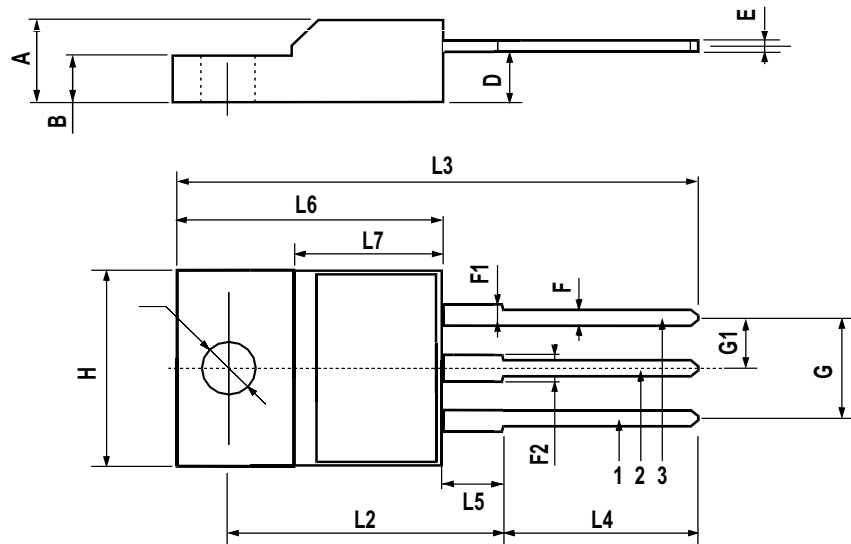
## TO-220 MECHANICAL DATA

| 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 |



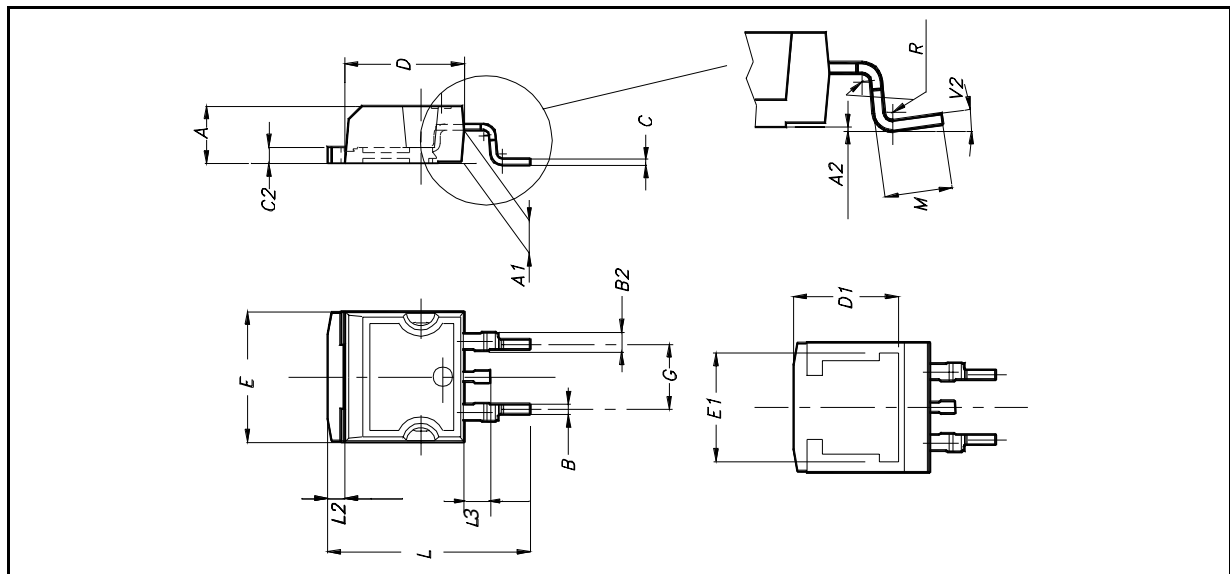
## TO-220FP MECHANICAL DATA

| 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 |

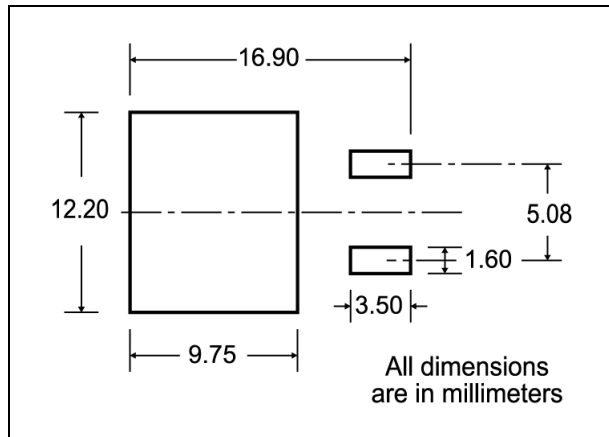


## D<sup>2</sup>PAK MECHANICAL DATA

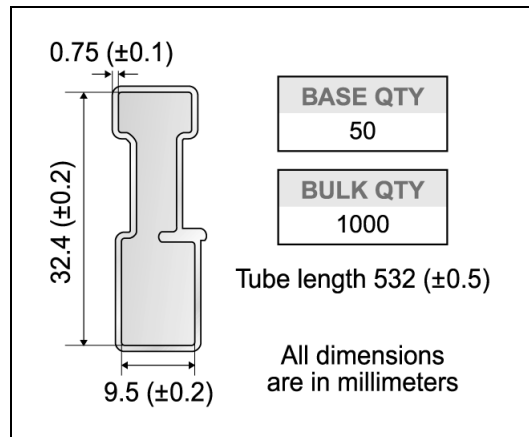
| DIM. | mm.  |     |       | inch  |       |       |
|------|------|-----|-------|-------|-------|-------|
|      | MIN. | TYP | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |     | 4.6   | 0.173 |       | 0.181 |
| A1   | 2.49 |     | 2.69  | 0.098 |       | 0.106 |
| A2   | 0.03 |     | 0.23  | 0.001 |       | 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°    |       |       |       |



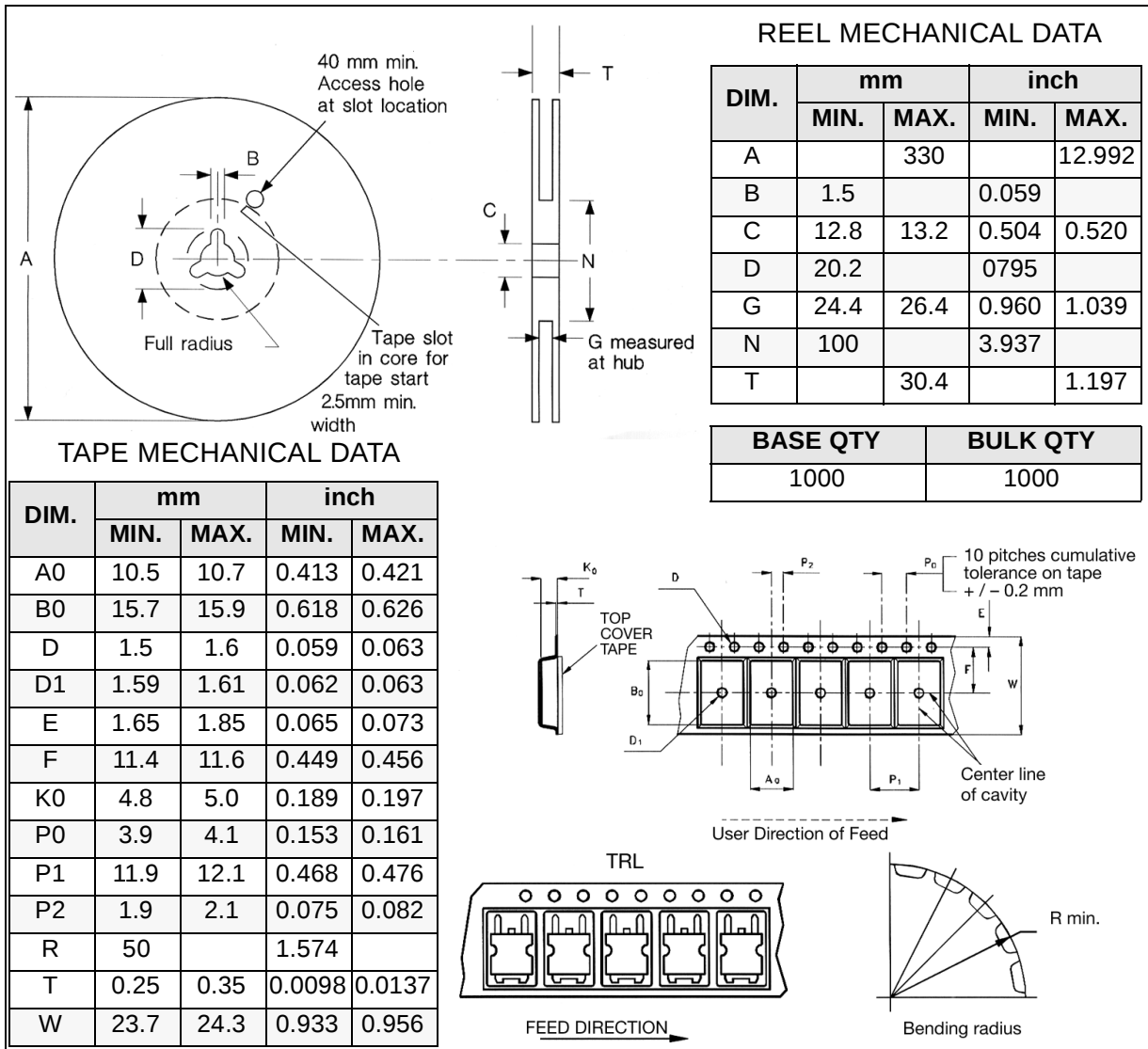
## D<sup>2</sup>PAK FOOTPRINT



## TUBE SHIPMENT (no suffix)\*



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



\* on sales type