



# STP5NK100Z - STF5NK100Z STW5NK100Z

N-CHANNEL 1000V - 2.7Ω - 3.5A TO-220/TO-220FP/TO-247  
Zener-Protected SuperMESH™ MOSFET

**Table 1: General Features**

| TYPE       | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>w</sub> |
|------------|------------------|---------------------|----------------|----------------|
| STF5NK100Z | 1000 V           | < 3.7 Ω             | 3.5 A (*)      | 30 W           |
| STP5NK100Z | 1000 V           | < 3.7 Ω             | 3.5 A          | 125 W          |
| STW5NK100Z | 1000 V           | < 3.7 Ω             | 3.5 A          | 125 W          |

- TYPICAL R<sub>DS(on)</sub> = 2.7 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- IMPROVED ESD CAPABILITY
- 100% AVALANCHE RATED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY

## DESCRIPTION

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strippbased 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.

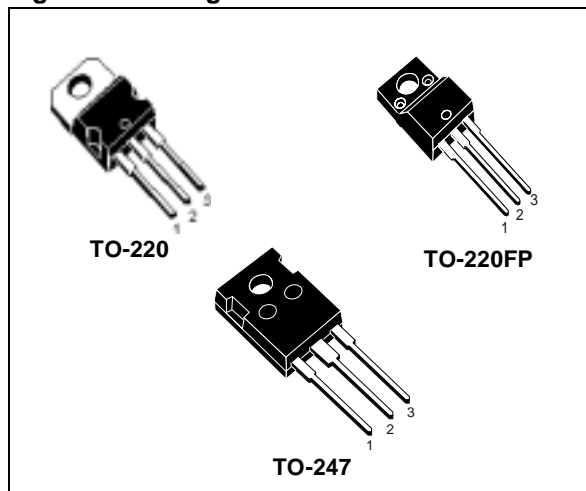
## APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES

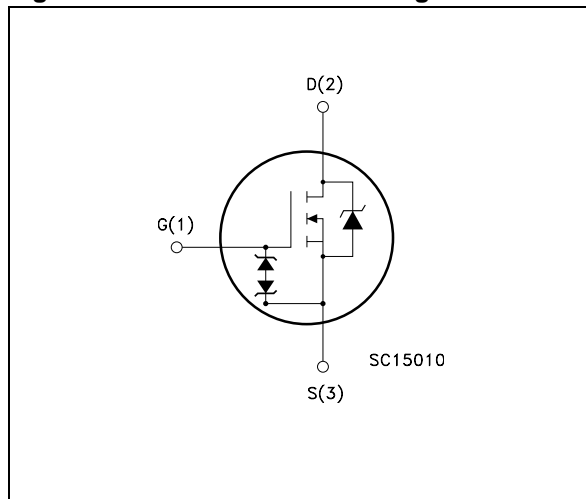
**Table 2: Order Codes**

| SALES TYPE | MARKING   | PACKAGE  | PACKAGING |
|------------|-----------|----------|-----------|
| STF5NK100Z | F5NK100Z  | TO-220FP | TUBE      |
| STP5NK100Z | P5NK100Z  | TO-220   | TUBE      |
| STW5NK100Z | W15NK100Z | TO-247   | TUBE      |

**Figure 1: Package**



**Figure 2: Internal Schematic Diagram**



**Table 3: Absolute Maximum ratings**

| Symbol                             | Parameter   | Value                    |            | Unit     |
|------------------------------------|---|--------------------------|------------|----------|
|                                    |   | STP5NK100Z<br>STW5NK100Z | STF5NK100Z |          |
| V <sub>DS</sub>                    | Drain-source Voltage (V <sub>GS</sub> = 0)            | 1000                     |            | V        |
| V <sub>DGR</sub>                   | Drain-gate Voltage (R <sub>GS</sub> = 20 kΩ)          | 1000                     |            | V        |
| V <sub>GS</sub>                    | Gate- source Voltage                                  | ± 30                     |            | V        |
| I <sub>D</sub>                     | Drain Current (continuous) at T <sub>C</sub> = 25°C   | 3.5                      | 3.5 (*)    | A        |
| I <sub>D</sub>                     | Drain Current (continuous) at T <sub>C</sub> = 100°C  | 2.2                      | 2.2 (*)    | A        |
| I <sub>DM</sub> (•)                | Drain Current (pulsed)                                | 14                       | 14 (*)     | 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> ≤ 3.5A, 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

**Table 4: Thermal Data**

|                       |  | TO-220<br>TO-247 | 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>l</sub>        | Maximum Lead Temperature For Soldering Purpose | 300              |          | °C   |

**Table 5: Avalanche Characteristics**

| Symbol          | Parameter  | Max Value | Unit |
|-----------------|--|-----------|------|
| I <sub>AR</sub> | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>j</sub> max)                                | 3.5       | 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) | 250       | mJ   |

**Table 6: 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    |

**PROTECTION FEATURES OF GATE-TO-SOURCE ZENER DIODES**

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

**ELECTRICAL CHARACTERISTICS** ( $T_{CASE} = 25^{\circ}C$  UNLESS OTHERWISE SPECIFIED)**Table 7: On /Off**

| Symbol        | Parameter  | Test Conditions   | Min. | Typ. | Max.     | Unit               |
|---------------|--|---|------|------|----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage                   | $I_D = 1 \text{ mA}, V_{GS} = 0$  | 1000 |      |          | V                  |
| $I_{DSS}$     | Zero Gate Voltage Drain Current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating},$<br>$T_C = 125^{\circ}C$ |      |      | 1<br>50  | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate-body Leakage Current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20 \text{ V}$   |      |      | $\pm 10$ | $\mu A$            |
| $V_{GS(th)}$  | 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                | $V_{GS} = 10 \text{ V}, I_D = 1.75 \text{ A}$   |      | 2.7  | 3.7      | $\Omega$           |

**Table 8: Dynamic**

| Symbol                   | Parameter                     | Test Conditions   | Min. | Typ. | Max. | Unit |
|--------------------------|-------------------------------|---|------|------|------|------|
| $g_{fs} (1)$             | Forward Transconductance      | $V_{DS} = 15 \text{ V}, I_D = 1.75 \text{ A}$   |      | 4    |      | S    |
| $C_{iss}$                | Input Capacitance             | $V_{DS} = 25 \text{ V}, f = 1 \text{ MHz},$<br>$V_{GS} = 0$   |      | 1154 |      | pF   |
| $C_{oss}$                | Output Capacitance            |   |      | 106  |      | pF   |
| $C_{rss}$                | Reverse Transfer Capacitance  |   |      | 21.3 |      | pF   |
| $C_{oss \text{ eq}} (3)$ | Equivalent Output Capacitance | $V_{GS} = 0 \text{ V}, V_{DS} = 0 \text{ to } 800 \text{ V}$  |      | 46.8 |      | pF   |
| $t_{d(on)}$              | Turn-on Delay Time            | $V_{DD} = 500 \text{ V}, I_D = 1.75 \text{ A},$<br>$R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$<br>(see Figure 21) |      | 22.5 |      | ns   |
| $t_r$                    | Rise Time                     |   |      | 7.7  |      | ns   |
| $t_{d(off)}$             | Turn-off-Delay Time           |   |      | 51.5 |      | ns   |
| $t_f$                    | Fall Time                     |   |      | 19   |      | ns   |
| $Q_g$                    | Total Gate Charge             | $V_{DD} = 800 \text{ V}, I_D = 3.5 \text{ A},$<br>$V_{GS} = 10 \text{ V}$<br>(see Figure 24)                    |      | 42   | 59   | nC   |
| $Q_{gs}$                 | Gate-Source Charge            |   |      | 7.3  |      | nC   |
| $Q_{gd}$                 | Gate-Drain Charge             |   |      | 21.7 |      | nC   |

**Table 9: Source Drain Diode**

| Symbol        | Parameter                     | Test Conditions   | Min. | Typ. | Max. | Unit    |
|---------------|-------------------------------|---|------|------|------|---------|
| $I_{SD}$      | Source-drain Current          |   |      |      | 3.5  | A       |
| $I_{SDM} (2)$ | Source-drain Current (pulsed) |   |      |      | 14   | A       |
| $V_{SD} (1)$  | Forward On Voltage            | $I_{SD} = 3.5 \text{ A}, V_{GS} = 0$  |      |      | 1.6  | V       |
| $t_{rr}$      | Reverse Recovery Time         | $I_{SD} = 3.5 \text{ A}, di/dt = 100 \text{ A}/\mu s$<br>$V_{DD} = 35 \text{ V}$<br>(see Figure 22)                     |      | 605  |      | ns      |
| $Q_{rr}$      | Reverse Recovery Charge       |   |      | 3.09 |      | $\mu C$ |
| $I_{RRM}$     | Reverse Recovery Current      |   |      | 10.5 |      | A       |
| $t_{rr}$      | Reverse Recovery Time         | $I_{SD} = 3.5 \text{ A}, di/dt = 100 \text{ A}/\mu s$<br>$V_{DD} = 35 \text{ V}, T_j = 150^{\circ}C$<br>(see Figure 22) |      | 742  |      | ns      |
| $Q_{rr}$      | Reverse Recovery Charge       |   |      | 4.2  |      | $\mu C$ |
| $I_{RRM}$     | Reverse Recovery Current      |   |      | 11.2 |      | A       |

(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%  $V_{DSS}$ .

Figure 3: Safe Operating Area For TO-220

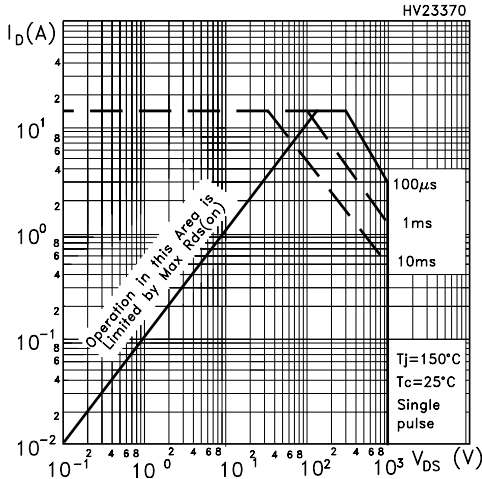


Figure 4: Safe Operating Area For TO-220FP

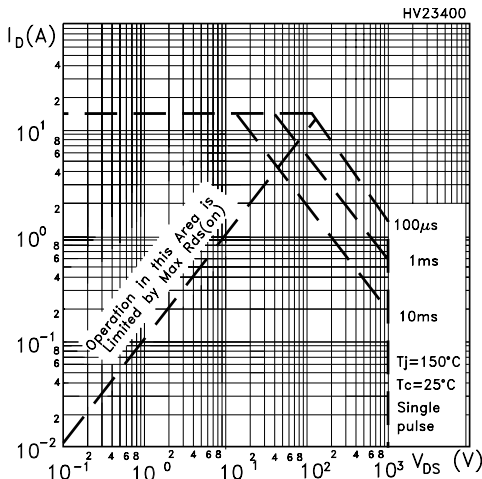


Figure 5: Safe Operating Area For TO-247

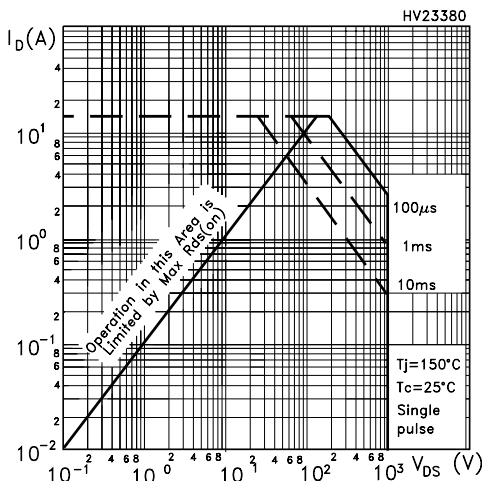


Figure 6: Thermal Impedance TO-220

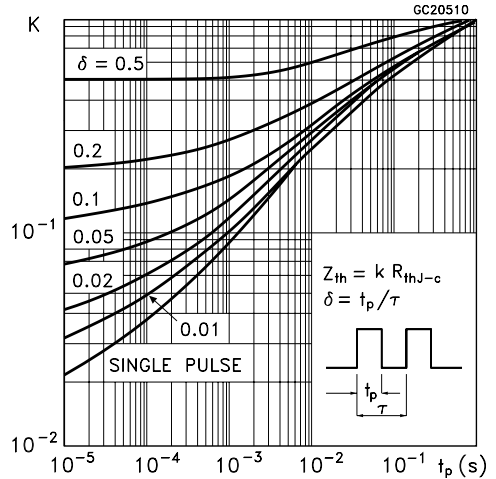


Figure 7: Thermal Impedance For TO-220FP

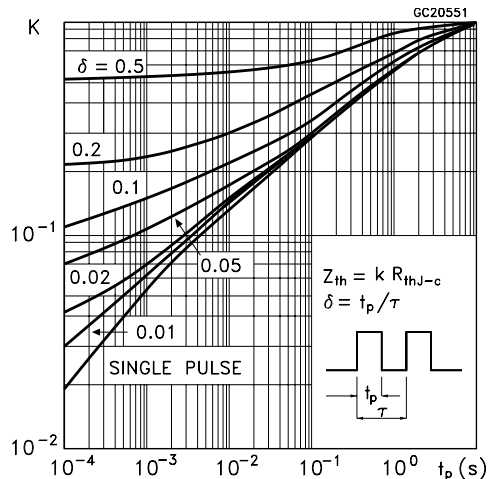


Figure 8: Thermal Impedance For TO-247

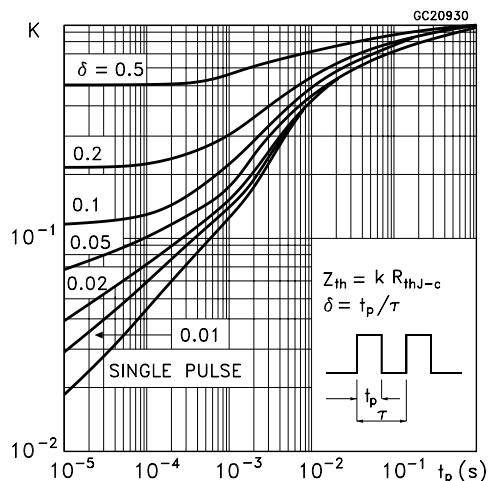


Figure 9: Output Characteristics

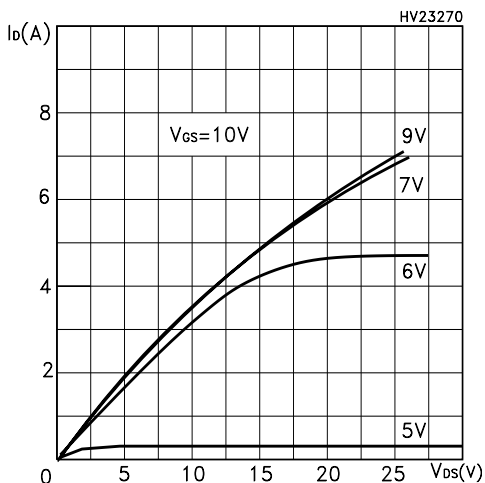


Figure 10: Transconductance

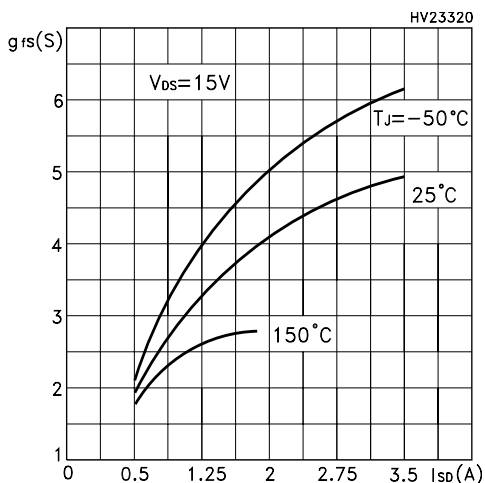


Figure 11: Gate Charge vs Gate-source Voltage

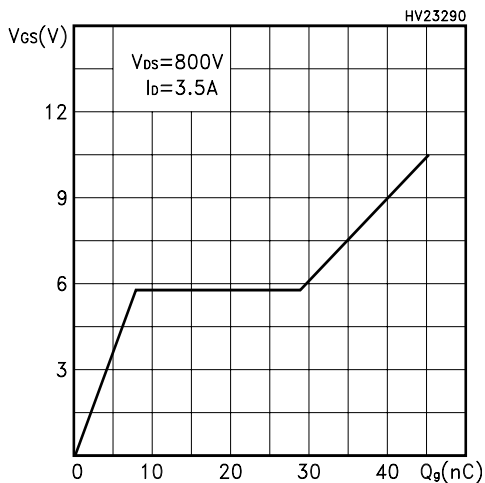


Figure 12: Transfer Characteristics

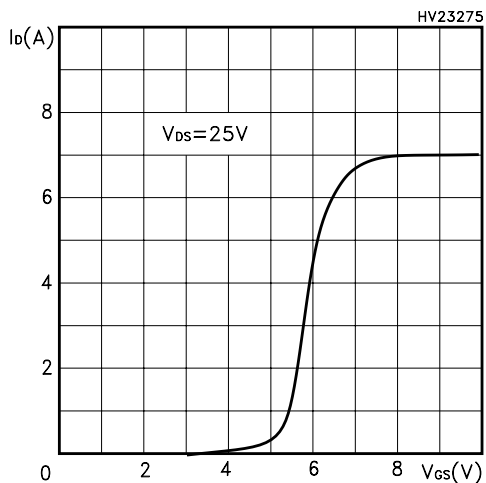


Figure 13: Static Drain-Source On Resistance

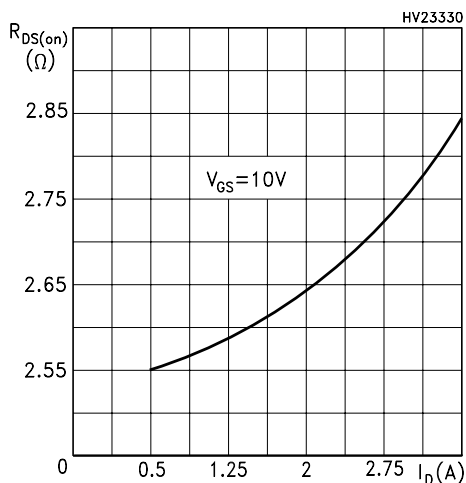


Figure 14: Capacitance Variations

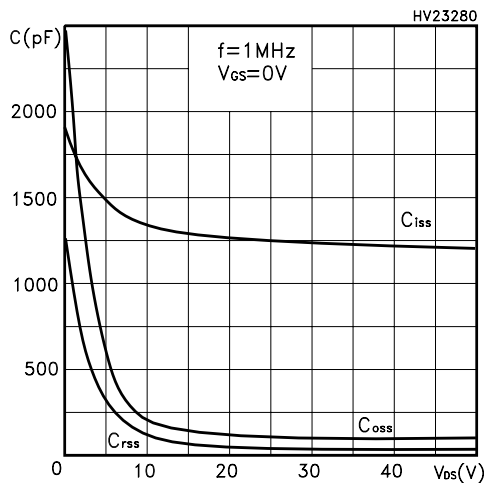


Figure 15: Normalized Gate Threshold Voltage vs Temperature

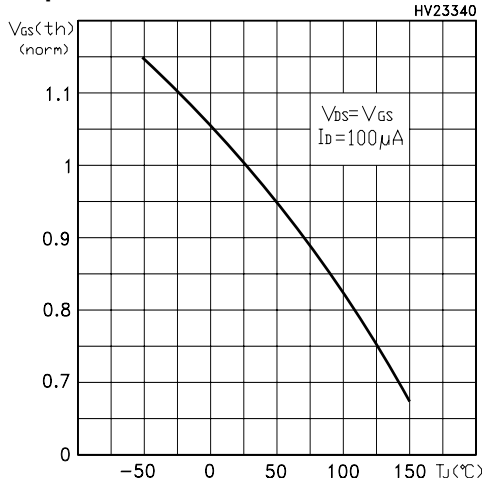


Figure 16: Source-Drain Forward Characteristics

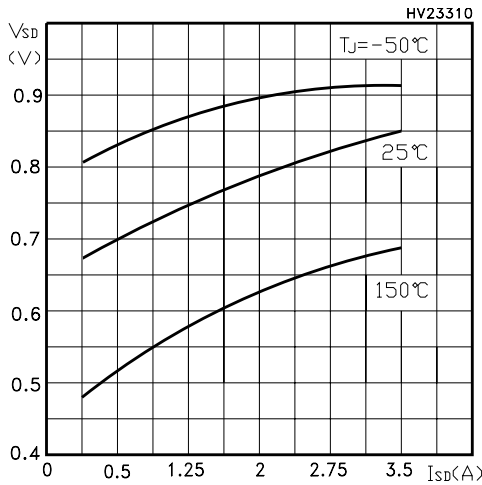


Figure 17: Maximum Avalanche Energy vs Temperature

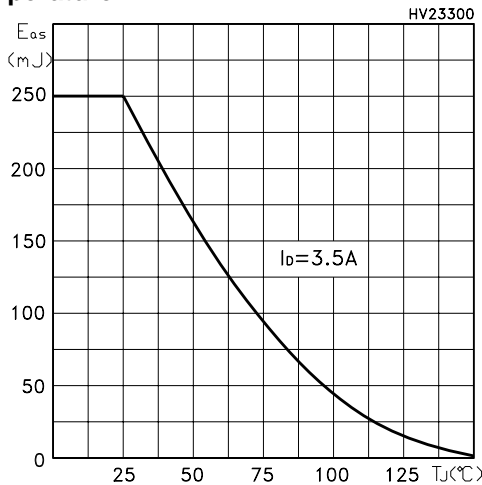


Figure 18: Normalized On Resistance vs Temperature

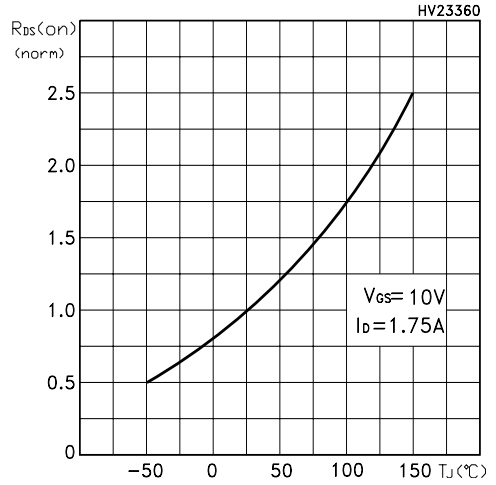


Figure 19: Normalized BV<sub>DSS</sub> vs Temperature

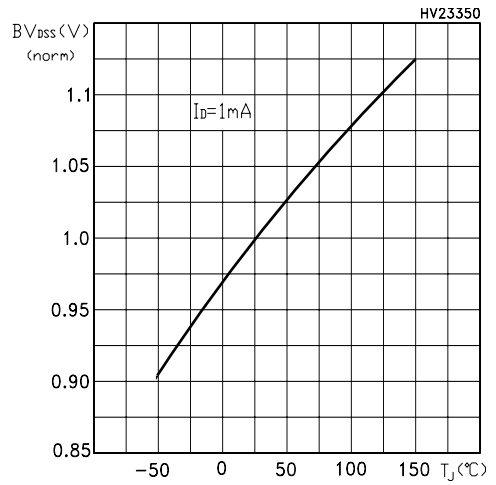


Figure 20: Unclamped Inductive Load Test Circuit

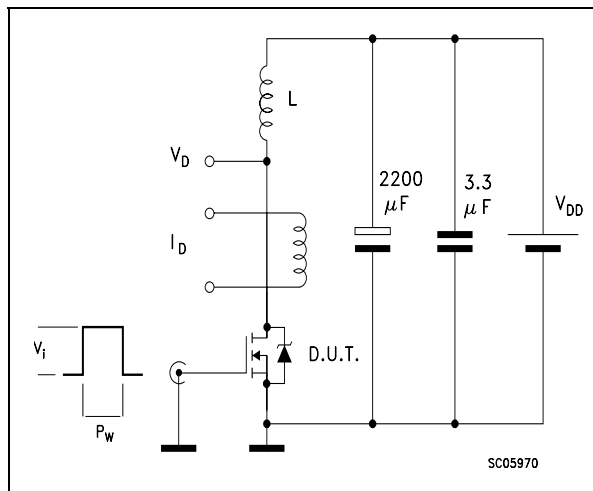


Figure 21: Switching Times Test Circuit For Resistive Load

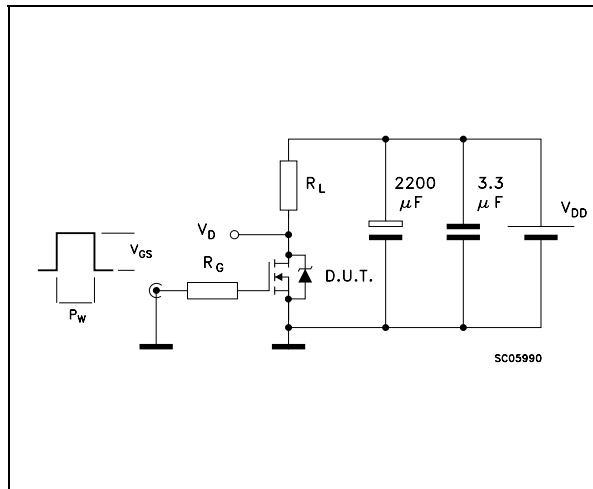


Figure 22: Test Circuit For Inductive Load Switching and Diode Recovery Times

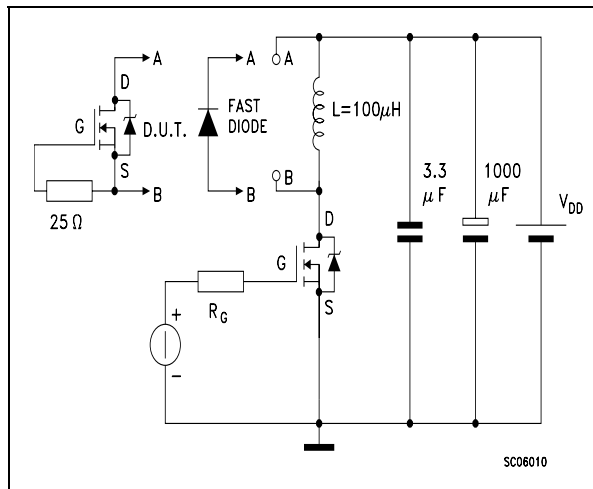


Figure 23: Unclamped Inductive Waferform

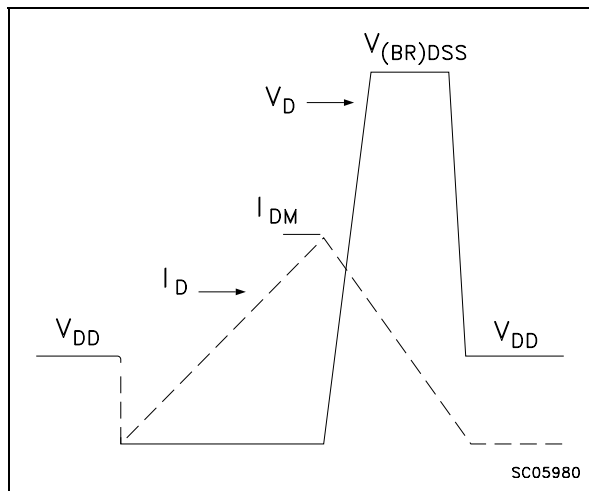
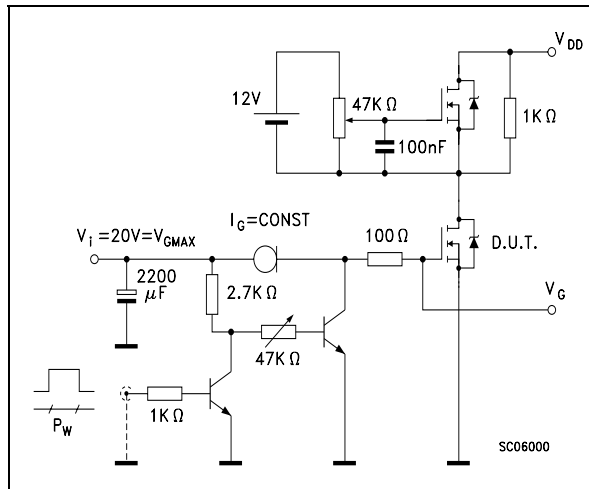
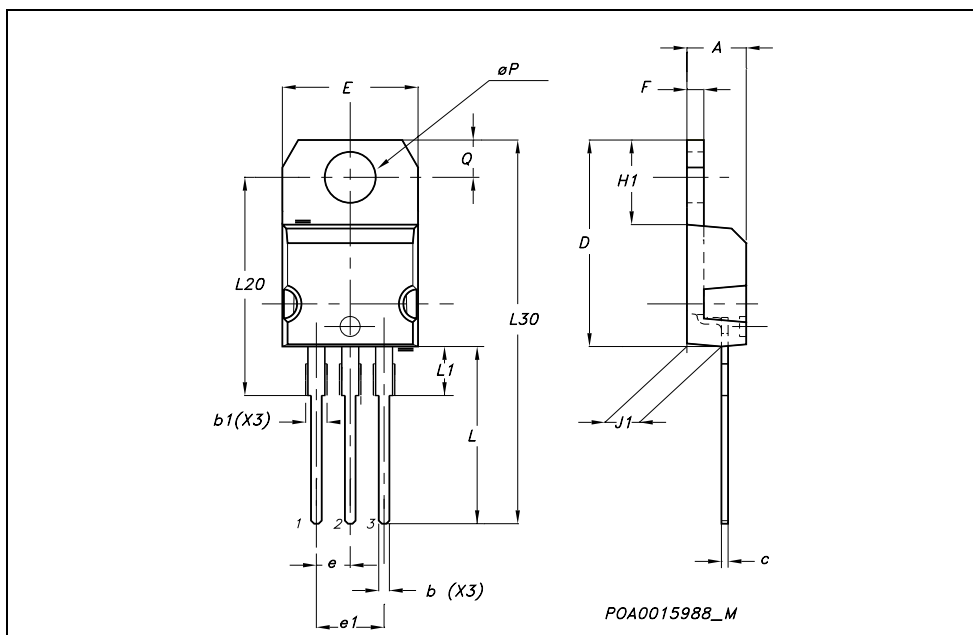


Figure 24: Gate Charge Test Circuit



TO-220 MECHANICAL DATA

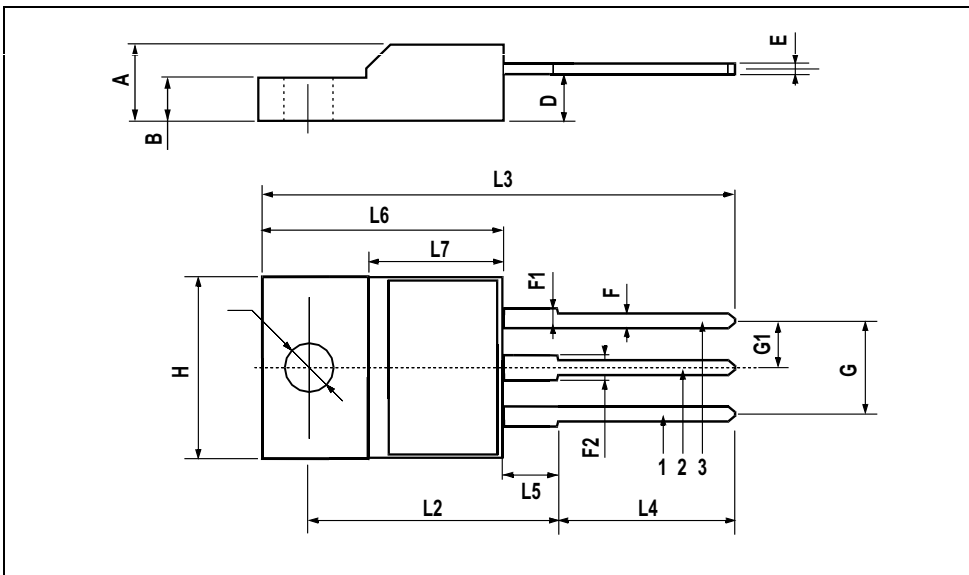
| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.40  |       | 4.60  | 0.173 |       | 0.181 |
| b    | 0.61  |       | 0.88  | 0.024 |       | 0.034 |
| b1   | 1.15  |       | 1.70  | 0.045 |       | 0.066 |
| c    | 0.49  |       | 0.70  | 0.019 |       | 0.027 |
| D    | 15.25 |       | 15.75 | 0.60  |       | 0.620 |
| E    | 10    |       | 10.40 | 0.393 |       | 0.409 |
| e    | 2.40  |       | 2.70  | 0.094 |       | 0.106 |
| e1   | 4.95  |       | 5.15  | 0.194 |       | 0.202 |
| F    | 1.23  |       | 1.32  | 0.048 |       | 0.052 |
| H1   | 6.20  |       | 6.60  | 0.244 |       | 0.256 |
| J1   | 2.40  |       | 2.72  | 0.094 |       | 0.107 |
| L    | 13    |       | 14    | 0.511 |       | 0.551 |
| L1   | 3.50  |       | 3.93  | 0.137 |       | 0.154 |
| L20  |       | 16.40 |       |       | 0.645 |       |
| L30  |       | 28.90 |       |       | 1.137 |       |
| øP   | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q    | 2.65  |       | 2.95  | 0.104 |       | 0.116 |





TO-220FP MECHANICAL DATA

| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |      | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |      | 2.75 | 0.098 |       | 0.108 |
| E    | 0.45 |      | 0.7  | 0.017 |       | 0.027 |
| F    | 0.75 |      | 1    | 0.030 |       | 0.039 |
| F1   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| F2   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| G    | 4.95 |      | 5.2  | 0.195 |       | 0.204 |
| G1   | 2.4  |      | 2.7  | 0.094 |       | 0.106 |
| H    | 10   |      | 10.4 | 0.393 |       | 0.409 |
| L2   |      | 16   |      |       | 0.630 |       |
| L3   | 28.6 |      | 30.6 | 1.126 |       | 1.204 |
| L4   | 9.8  |      | 10.6 | .0385 |       | 0.417 |
| L5   | 2.9  |      | 3.6  | 0.114 |       | 0.141 |
| L6   | 15.9 |      | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |      | 9.3  | 0.354 |       | 0.366 |
| Ø    | 3    |      | 3.2  | 0.118 |       | 0.126 |



**TO-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 |       |

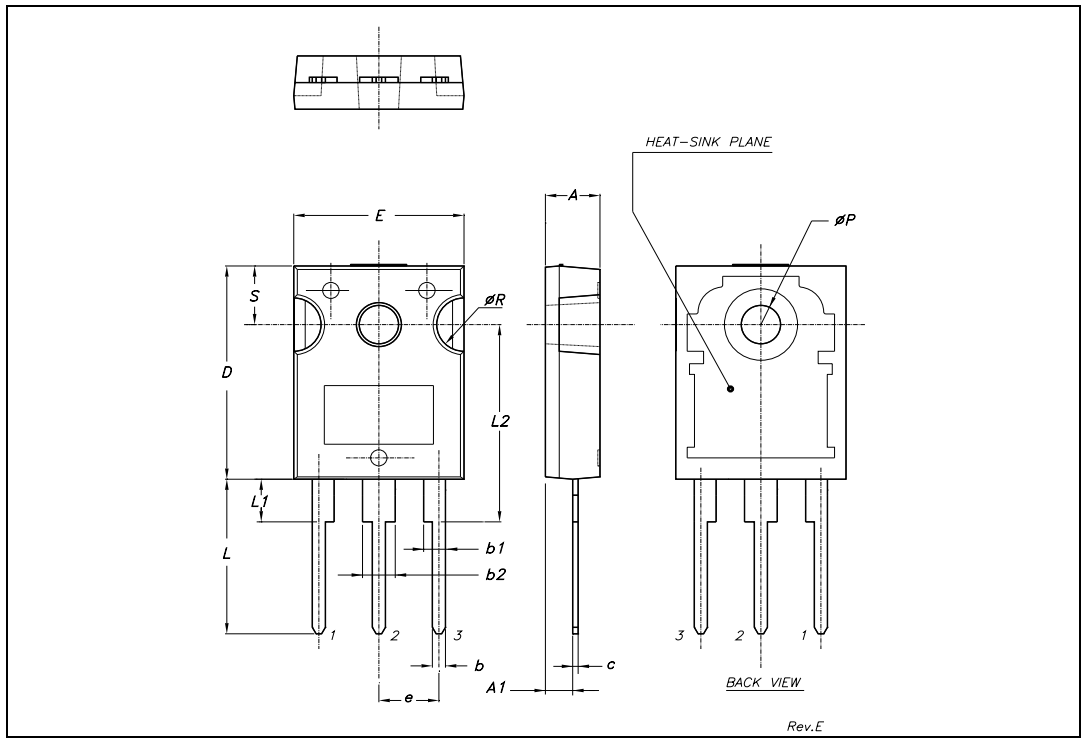


Table 10: Revision History

| Date        | Revision | Description of Changes |
|-------------|----------|------------------------|
| 27-Sep-2004 | 1        | First release.         |
| 08-Oct-2004 | 2        | Final datasheet        |

Information furnished is believed to be accurate and reliable. However, STMicroelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of STMicroelectronics. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. STMicroelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of STMicroelectronics.

The ST logo is a registered trademark of STMicroelectronics  
All other names are the property of their respective owners

© 2004 STMicroelectronics - All Rights Reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America