



## STY60NM50

### N-CHANNEL 500V - 0.045Ω - 60A Max247 Zener-Protected MDmesh™ Power MOSFET

| TYPE      | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-----------|------------------|---------------------|----------------|
| STY60NM50 | 500V             | < 0.05Ω             | 60 A           |

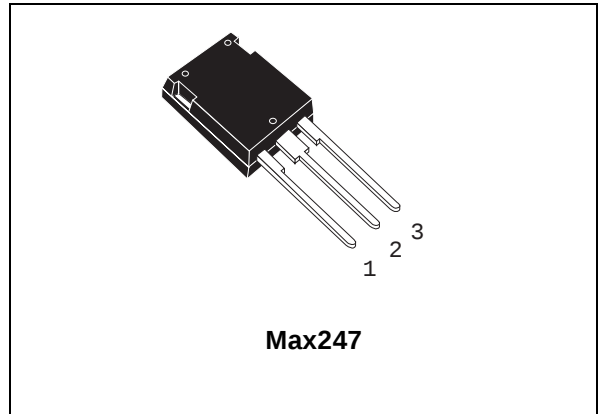
- TYPICAL R<sub>DS(on)</sub> = 0.045Ω
- HIGH dv/dt AND AVALANCHE CAPABILITIES
- IMPROVED ESD CAPABILITY
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE
- TIGHT PROCESS CONTROL
- INDUSTRY'S LOWEST ON-RESISTANCE

#### DESCRIPTION

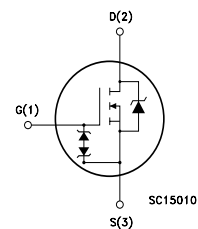
The MDmesh™ is a new revolutionary MOSFET technology that associates the Multiple Drain process with the Company's PowerMESH™ horizontal layout. The resulting product has an outstanding low on-resistance, impressively high dv/dt and excellent avalanche characteristics. The adoption of the Company's proprietary strip technique yields overall dynamic performance that is significantly better than that of similar competition's products.

#### APPLICATIONS

The MDmesh™ family is very suitable for increasing power density of high voltage converters allowing system miniaturization and higher efficiencies.



#### INTERNAL SCHEMATIC DIAGRAM



#### ABSOLUTE MAXIMUM RATINGS

| Symbol                | Parameter                                            | Value      | Unit |
|-----------------------|------------------------------------------------------|------------|------|
| 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  | 60         | A    |
| I <sub>D</sub>        | Drain Current (continuous) at T <sub>C</sub> = 100°C | 37.8       | A    |
| I <sub>DM</sub> (•)   | Drain Current (pulsed)                               | 240        | A    |
| P <sub>TOT</sub>      | Total Dissipation at T <sub>C</sub> = 25°C           | 560        | W    |
| V <sub>ESD(G-S)</sub> | Gate source ESD(HBM-C=100pF, R=15KΩ)                 | 6          | KV   |
|                       | Derating Factor                                      | 4.5        | W/°C |
| dv/dt (1)             | Peak Diode Recovery voltage slope                    | 15         | V/ns |
| T <sub>stg</sub>      | Storage Temperature                                  | -65 to 150 | °C   |
| T <sub>j</sub>        | Max. Operating Junction Temperature                  | 150        | °C   |

(•)Pulse width limited by safe operating area  
August 2002

(1)I<sub>SD</sub> ≤ 60A, di/dt ≤ 400A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>

## STY60NM50

### THERMAL DATA

|                |                                                |     |      |      |
|----------------|------------------------------------------------|-----|------|------|
| Rthj-case      | Thermal Resistance Junction-case               | Max | 0.22 | °C/W |
| Rthj-amb       | Thermal Resistance Junction-ambient            | Max | 30   | °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)                                | 30        | 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> = 35 V) | 1.4       | J    |

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

| 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, T <sub>C</sub> = 125 °C |      |      | 10<br>100 | µA<br>µA |
| I <sub>GSS</sub>     | Gate-body Leakage Current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ± 20V                                                               |      |      | ± 10      | µA       |

### ON (1)

| Symbol              | Parameter                         | Test Conditions                                            | Min. | Typ.  | Max. | Unit |
|---------------------|-----------------------------------|------------------------------------------------------------|------|-------|------|------|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250µA | 3    | 4     | 5    | V    |
| R <sub>DS(on)</sub> | Static Drain-source On Resistance | V <sub>GS</sub> = 10V, I <sub>D</sub> = 30A                |      | 0.045 | 0.05 | Ω    |

### DYNAMIC

| Symbol              | Parameter                    | Test Conditions                                                                         | Min. | Typ. | Max. | Unit |
|---------------------|------------------------------|-----------------------------------------------------------------------------------------|------|------|------|------|
| g <sub>fs</sub> (1) | Forward Transconductance     | V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub> ,<br>I <sub>D</sub> = 30A |      | 35   |      | S    |
| C <sub>iss</sub>    | Input Capacitance            | V <sub>DS</sub> = 25V, f = 1 MHz, V <sub>GS</sub> = 0                                   |      | 7500 |      | pF   |
| C <sub>oss</sub>    | Output Capacitance           |                                                                                         |      | 980  |      | pF   |
| C <sub>rss</sub>    | Reverse Transfer Capacitance |                                                                                         |      | 200  |      | pF   |
| R <sub>G</sub>      | Gate Input Resistance        | f=1 MHz Gate DC Bias = 0<br>Test Signal Level = 20mV<br>Open Drain                      |      | 1.5  |      | Ω    |

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

# ELECTRICAL CHARACTERISTICS (CONTINUED)

## SWITCHING ON

| Symbol      | Parameter          | Test Conditions                                                 | Min. | Typ. | Max. | Unit |
|-------------|--------------------|-----------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD} = 250V, I_D = 30A$                                      |      | 51   |      | ns   |
| $t_r$       | Rise Time          | $R_G = 4.7\Omega, V_{GS} = 10V$<br>(see test circuit, Figure 3) |      | 58   |      | ns   |
| $Q_g$       | Total Gate Charge  | $V_{DD} = 400V, I_D = 60A,$<br>$V_{GS} = 10V$                   |      | 190  | 266  | nC   |
| $Q_{gs}$    | Gate-Source Charge |                                                                 |      | 53   |      | nC   |
| $Q_{gd}$    | Gate-Drain Charge  |                                                                 |      | 97   |      | nC   |

## SWITCHING OFF

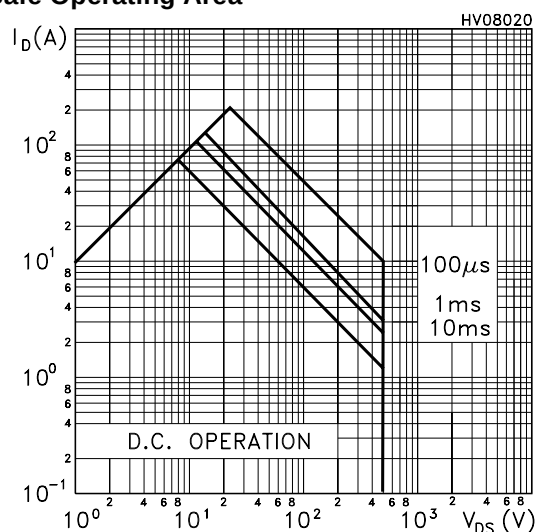
| Symbol         | Parameter             | Test Conditions                                                 | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|-----------------------------------------------------------------|------|------|------|------|
| $t_r(V_{off})$ | Off-voltage Rise Time | $V_{DD} = 400V, I_D = 60A,$                                     |      | 51   |      | ns   |
| $t_f$          | Fall Time             | $R_G = 4.7\Omega, V_{GS} = 10V$<br>(see test circuit, Figure 5) |      | 46   |      | ns   |
| $t_c$          | Cross-over Time       |                                                                 |      | 108  |      | ns   |

## SOURCE DRAIN DIODE

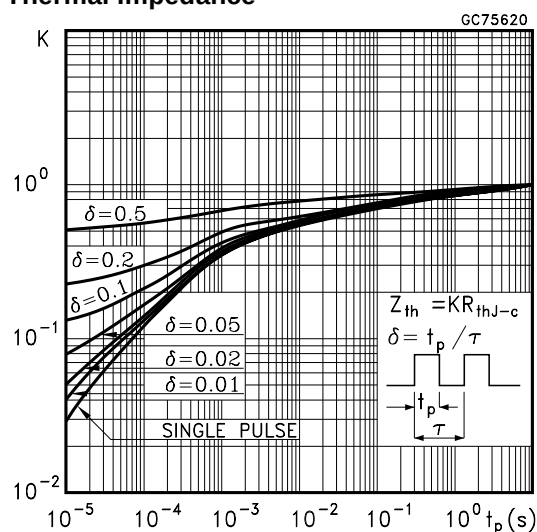
| Symbol        | Parameter                     | Test Conditions                     | Min. | Typ. | Max. | Unit    |
|---------------|-------------------------------|-------------------------------------|------|------|------|---------|
| $I_{SD}$      | Source-drain Current          |                                     |      |      | 60   | A       |
| $I_{SDM} (2)$ | Source-drain Current (pulsed) |                                     |      |      | 240  | A       |
| $V_{SD} (1)$  | Forward On Voltage            | $I_{SD} = 60A, V_{GS} = 0$          |      |      | 1.5  | V       |
| $t_{rr}$      | Reverse Recovery Time         | $I_{SD} = 60A, di/dt = 100A/\mu s,$ |      | 532  |      | ns      |
| $Q_{rr}$      | Reverse Recovery Charge       | $V_{DD} = 100V, T_J = 25^\circ C$   |      | 9.9  |      | $\mu C$ |
| $I_{RRM}$     | Reverse Recovery Current      | (see test circuit, Figure 5)        |      | 37   |      | A       |
| $t_{rr}$      | Reverse Recovery Time         | $I_{SD} = 60A, di/dt = 100A/\mu s,$ |      | 636  |      | ns      |
| $Q_{rr}$      | Reverse Recovery Charge       | $V_{DD} = 100V, T_J = 150^\circ C$  |      | 13.4 |      | $\mu C$ |
| $I_{RRM}$     | Reverse Recovery Current      | (see test circuit, Figure 5)        |      | 42   |      | A       |

Note: 1. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %.  
2. Pulse width limited by safe operating area.

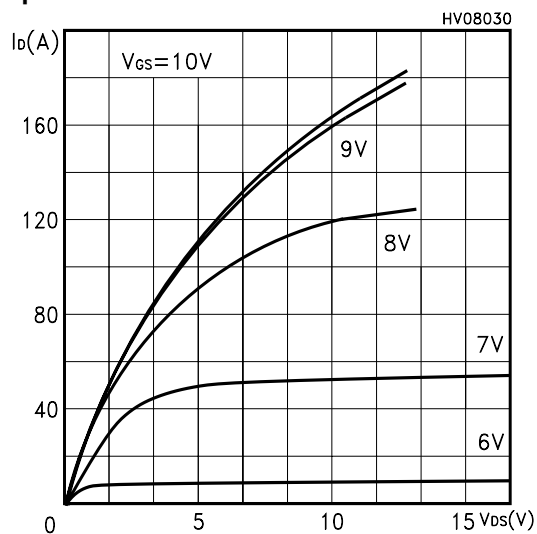
## Safe Operating Area



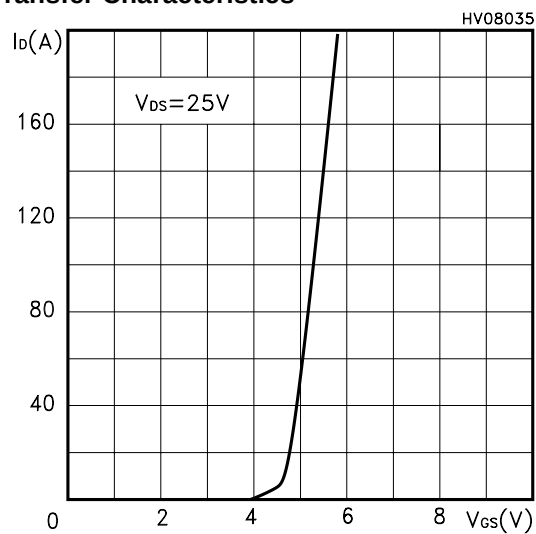
## Thermal Impedance



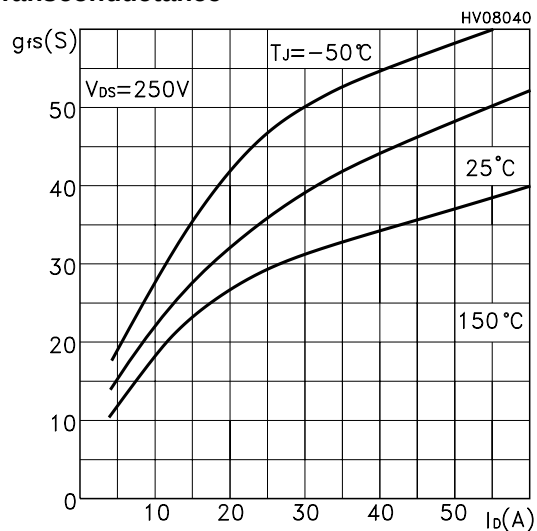
## Output Characteristics



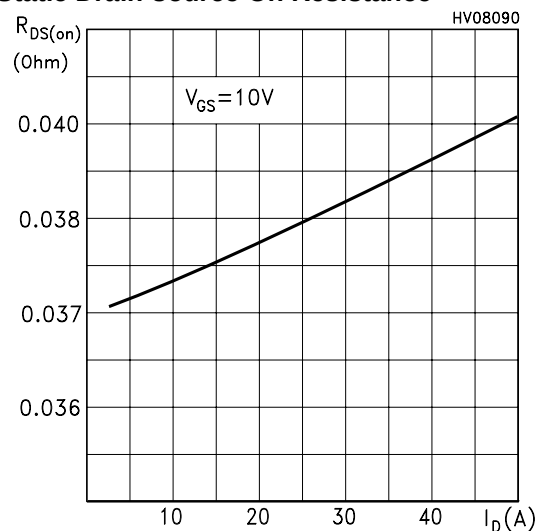
## Transfer Characteristics



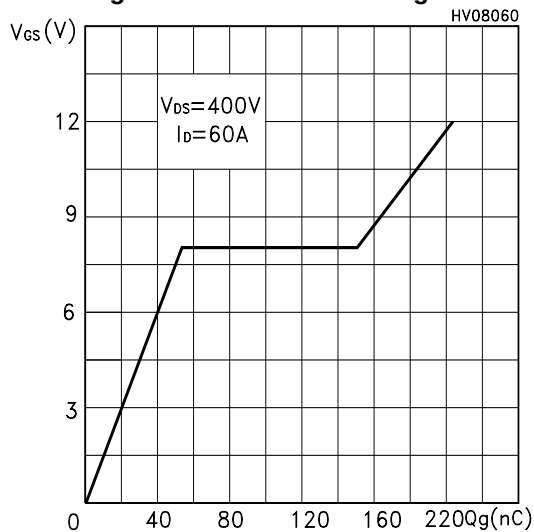
## Transconductance



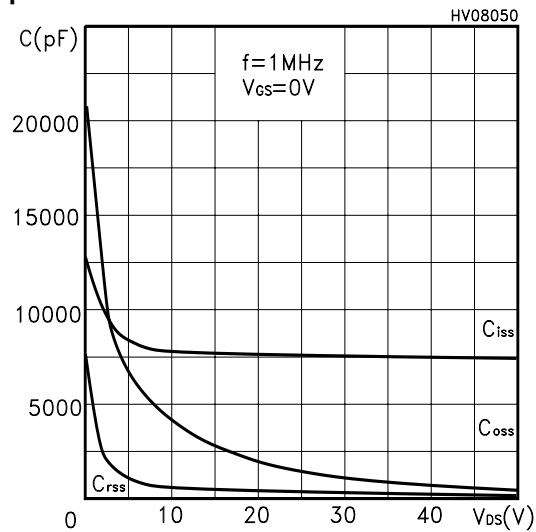
## Static Drain-source On Resistance



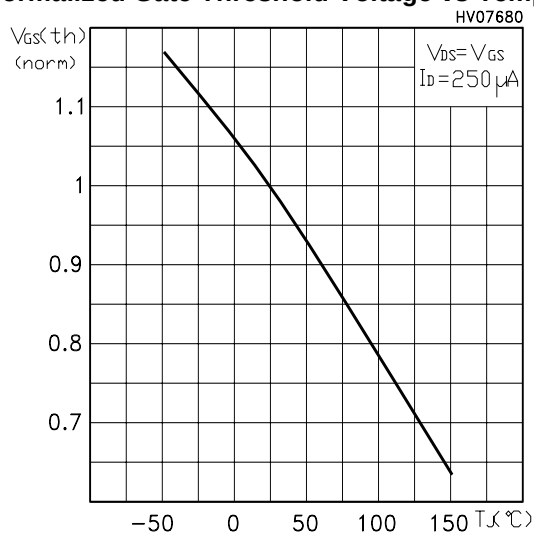
## Gate Charge vs Gate-source Voltage



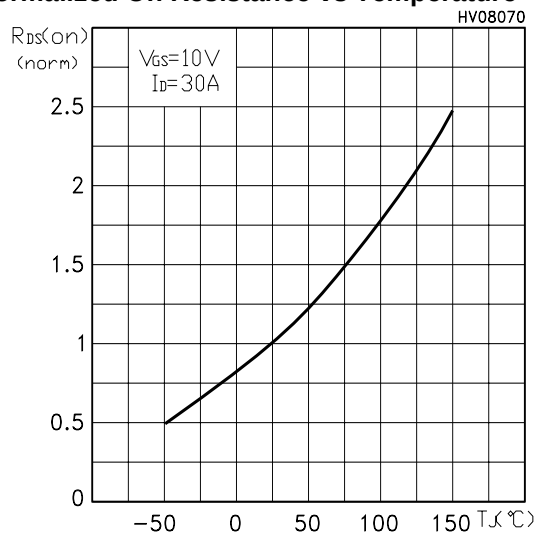
## Capacitance Variations



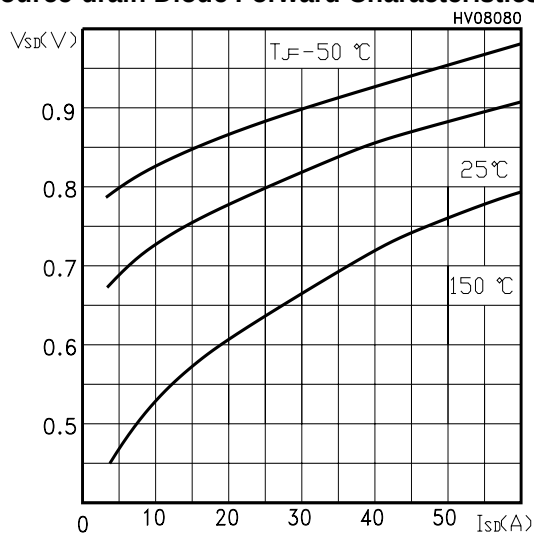
Normalized Gate Threshold Voltage vs Temp.



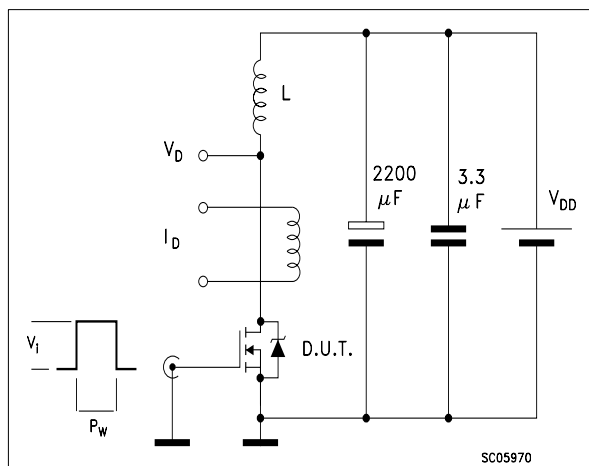
Normalized On Resistance vs Temperature



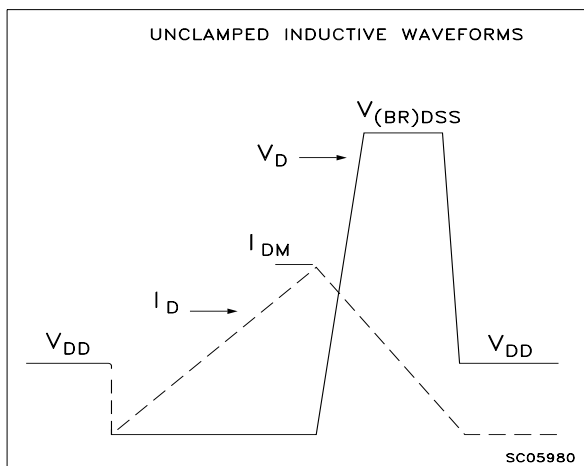
Source-drain Diode Forward Characteristics



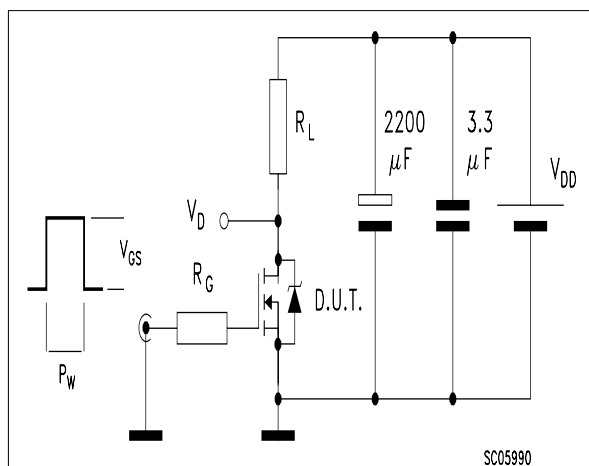
**Fig. 1: Unclamped Inductive Load Test Circuit**



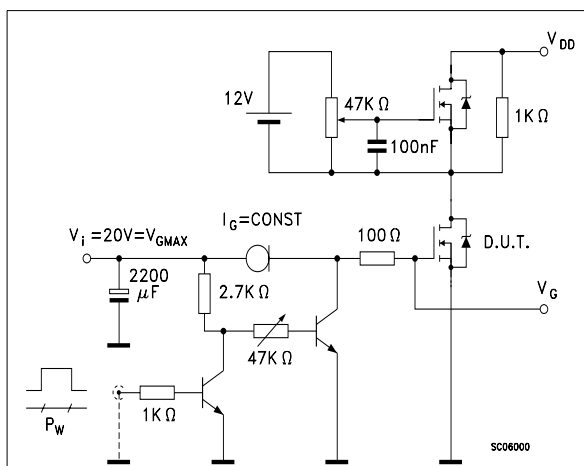
**Fig. 2: Unclamped Inductive Waveform**



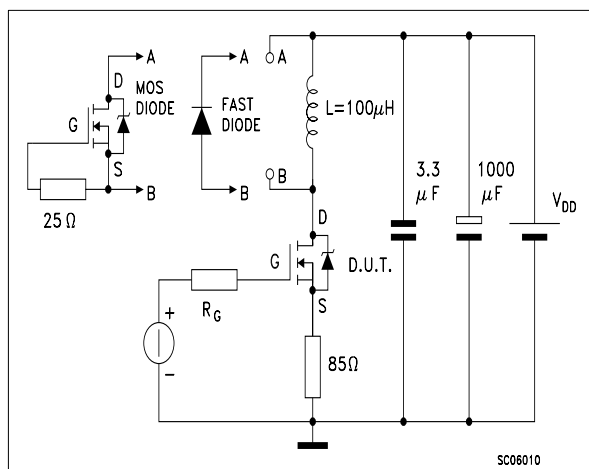
**Fig. 3: Switching Times Test Circuit For Resistive Load**



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

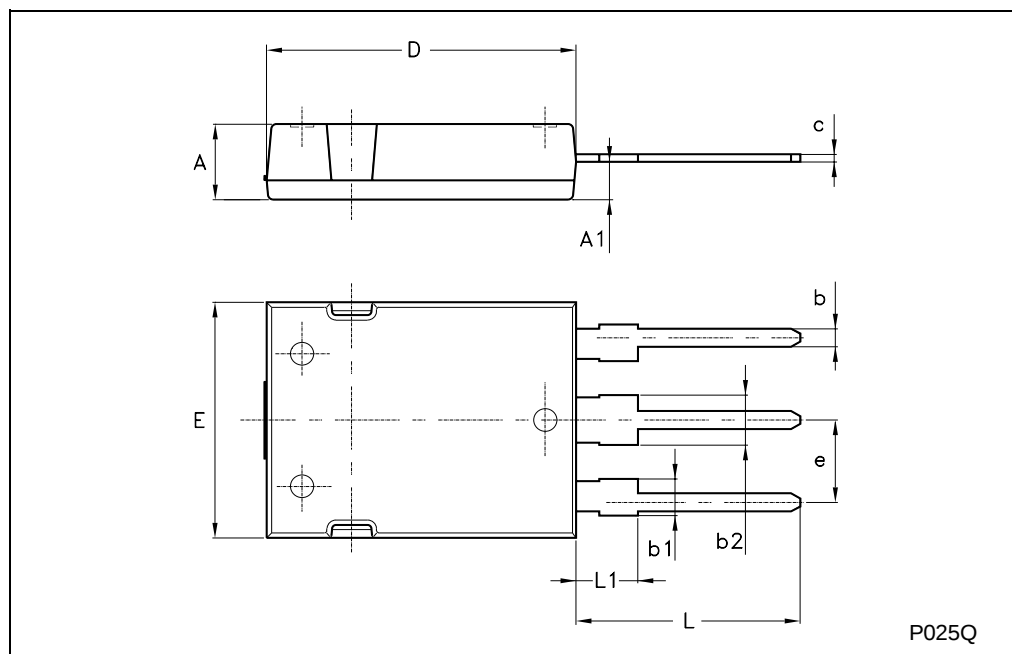


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



Max247 MECHANICAL DATA

| DIM. | mm    |      |       | inch |      |      |
|------|-------|------|-------|------|------|------|
|      | MIN.  | TYP. | MAX.  | MIN. | TYP. | MAX. |
| A    | 4.70  |      | 5.30  |      |      |      |
| A1   | 2.20  |      | 2.60  |      |      |      |
| b    | 1.00  |      | 1.40  |      |      |      |
| b1   | 2.00  |      | 2.40  |      |      |      |
| b2   | 3.00  |      | 3.40  |      |      |      |
| c    | 0.40  |      | 0.80  |      |      |      |
| D    | 19.70 |      | 20.30 |      |      |      |
| e    | 5.35  |      | 5.55  |      |      |      |
| E    | 15.30 |      | 15.90 |      |      |      |
| L    | 14.20 |      | 15.20 |      |      |      |
| L1   | 3.70  |      | 4.30  |      |      |      |



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