

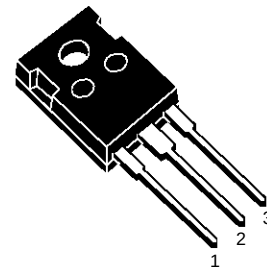
## N - CHANNEL ENHANCEMENT MODE POWER MOSFET

| TYPE     | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|----------|------------------|---------------------|----------------|
| STW33N20 | 200 V            | < 0.085 $\Omega$    | 33 A           |

- TYPICAL R<sub>DS(on)</sub> = 0.073  $\Omega$
- AVALANCHE RUGGED TECHNOLOGY
- 100% AVALANCHE TESTED
- REPETITIVE AVALANCHE DATA AT 100 °C
- LOW GATE CHARGE
- HIGH CURRENT CAPABILITY
- 150 °C OPERATING TEMPERATURE
- APPLICATION ORIENTED CHARACTERIZATION

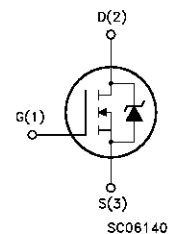
### APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- SOLENOID AND RELAY DRIVERS
- DC-DC CONVERTERS & DC-AC INVERTERS
- TELECOMMUNICATION POWER SUPPLIES
- INDUSTRIAL MOTOR DRIVES



TO-247

### INTERNAL SCHEMATIC DIAGRAM



### ABSOLUTE MAXIMUM RATINGS

| Symbol              | Parameter                                              | Value      | Unit |
|---------------------|--------------------------------------------------------|------------|------|
| V <sub>DS</sub>     | Drain-source Voltage (V <sub>GS</sub> = 0)             | 200        | V    |
| V <sub>DGR</sub>    | Drain- gate Voltage (R <sub>GS</sub> = 20 k $\Omega$ ) | 200        | V    |
| V <sub>GS</sub>     | Gate-source Voltage                                    | $\pm 20$   | V    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 25 °C   | 33         | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 100 °C  | 20         | A    |
| I <sub>DM</sub> (•) | Drain Current (pulsed)                                 | 132        | A    |
| P <sub>tot</sub>    | Total Dissipation at T <sub>c</sub> = 25 °C            | 180        | W    |
|                     | Derating Factor                                        | 1.44       | W/°C |
| 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

**THERMAL DATA**

|                |                                                |     |      |               |
|----------------|------------------------------------------------|-----|------|---------------|
| $R_{thj-case}$ | Thermal Resistance Junction-case               | Max | 0.66 | $^{\circ}C/W$ |
| $R_{thj-amb}$  | Thermal Resistance Junction-ambient            | Max | 30   | $^{\circ}C/W$ |
| $R_{thc-sink}$ | Thermal Resistance Case-sink                   | Typ | 0.1  | $^{\circ}C/W$ |
| $T_l$          | Maximum Lead Temperature For Soldering Purpose |     | 300  | $^{\circ}C$   |

**AVALANCHE CHARACTERISTICS**

| Symbol   | Parameter                                                                                           | Max Value | Unit |
|----------|-----------------------------------------------------------------------------------------------------|-----------|------|
| $I_{AR}$ | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max, $\delta < 1\%$ ) | 33        | A    |
| $E_{AS}$ | Single Pulse Avalanche Energy (starting $T_j = 25^{\circ}C$ , $I_D = I_{AR}$ , $V_{DD} = 50 V$ )    | 600       | mJ   |

**ELECTRICAL CHARACTERISTICS** ( $T_{case} = 25^{\circ}C$  unless otherwise specified)

**OFF**

| Symbol        | Parameter                                        | Test Conditions                                                                   | Min. | Typ. | Max.      | Unit               |
|---------------|--------------------------------------------------|-----------------------------------------------------------------------------------|------|------|-----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage                   | $I_D = 250 \mu A$ $V_{GS} = 0$                                                    | 200  |      |           | V                  |
| $I_{DSS}$     | Zero Gate Voltage Drain Current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating}$ $T_c = 100^{\circ}C$ |      |      | 10<br>100 | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate-body Leakage Current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20 V$                                                               |      |      | $\pm 100$ | nA                 |

**ON (\*)**

| Symbol       | Parameter                         | Test Conditions                                              | Min. | Typ.  | Max.  | Unit     |
|--------------|-----------------------------------|--------------------------------------------------------------|------|-------|-------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}$ $I_D = 250 \mu A$                          | 2    | 3     | 4     | V        |
| $R_{DS(on)}$ | Static Drain-source On Resistance | $V_{GS} = 10 V$ $I_D = 16 A$                                 |      | 0.073 | 0.085 | $\Omega$ |
| $I_{D(on)}$  | On State Drain Current            | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$<br>$V_{GS} = 10 V$ | 33   |       |       | A        |

**DYNAMIC**

| Symbol       | Parameter                    | Test Conditions                                        | Min. | Typ. | Max. | Unit |
|--------------|------------------------------|--------------------------------------------------------|------|------|------|------|
| $g_{fs} (*)$ | Forward Transconductance     | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ $I_D = 16 A$ | 10   | 22   |      | S    |
| $C_{iss}$    | Input Capacitance            | $V_{DS} = 25 V$ $f = 1 MHz$ $V_{GS} = 0$               |      | 3500 | 4500 | pF   |
| $C_{oss}$    | Output Capacitance           |                                                        |      | 550  | 700  | pF   |
| $C_{rss}$    | Reverse Transfer Capacitance |                                                        |      | 120  | 160  | pF   |

**ELECTRICAL CHARACTERISTICS** (continued)**SWITCHING ON**

| Symbol         | Parameter             | Test Conditions                                                                                                           | Min. | Typ. | Max. | Unit       |
|----------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on Time          | $V_{DD} = 100\text{ V}$ $I_D = 16\text{ A}$                                                                               |      | 25   | 40   | ns         |
| $t_r$          | Rise Time             | $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 3)                                                |      | 50   | 70   | ns         |
| $(di/dt)_{on}$ | Turn-on Current Slope | $V_{DD} = 160\text{ V}$ $I_D = 33\text{ A}$<br>$R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 5) |      | 800  |      | A/ $\mu$ s |
| $Q_g$          | Total Gate Charge     | $V_{DD} = 160\text{ V}$ $I_D = 33\text{ A}$ $V_{GS} = 10\text{ V}$                                                        |      | 110  | 160  | nC         |
| $Q_{gs}$       | Gate-Source Charge    |                                                                                                                           |      | 17   |      | nC         |
| $Q_{gd}$       | Gate-Drain Charge     |                                                                                                                           |      | 50   |      | nC         |

**SWITCHING OFF**

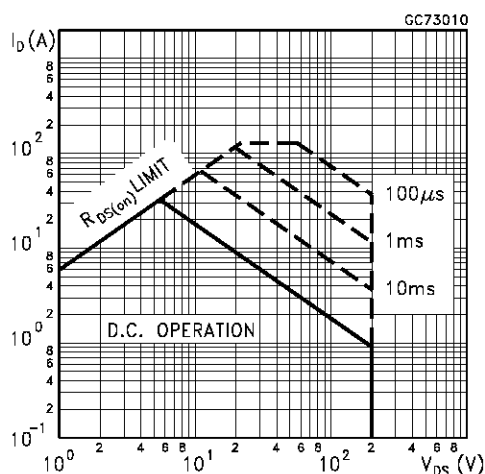
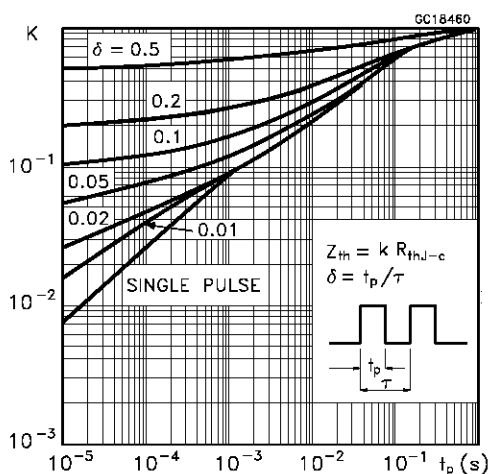
| Symbol         | Parameter             | Test Conditions                                                            | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|----------------------------------------------------------------------------|------|------|------|------|
| $t_r(V_{off})$ | Off-voltage Rise Time | $V_{DD} = 160\text{ V}$ $I_D = 33\text{ A}$                                |      | 30   | 45   | ns   |
| $t_f$          | Fall Time             | $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 5) |      | 30   | 45   | ns   |
| $t_c$          | Cross-over Time       |                                                                            |      | 60   | 90   | ns   |

**SOURCE DRAIN DIODE**

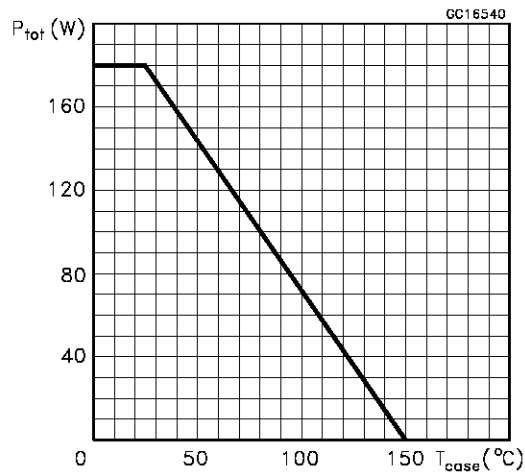
| Symbol             | Parameter                     | Test Conditions                                                                                                                                        | Min. | Typ. | Max. | Unit          |
|--------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$           | Source-drain Current          |                                                                                                                                                        |      |      | 33   | A             |
| $I_{SDM}(\bullet)$ | Source-drain Current (pulsed) |                                                                                                                                                        |      |      | 132  | A             |
| $V_{SD} (*)$       | Forward On Voltage            | $I_{SD} = 10\text{ A}$ $V_{GS} = 0$                                                                                                                    |      |      | 1.6  | V             |
| $t_{rr}$           | Reverse Recovery Time         | $I_{SD} = 33\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ $T_j = 150\text{ }^\circ\text{C}$<br>(see test circuit, figure 5) |      | 400  |      | ns            |
| $Q_{rr}$           | Reverse Recovery Charge       |                                                                                                                                                        |      | 5.6  |      | $\mu\text{C}$ |
| $I_{RRM}$          | Reverse Recovery Current      |                                                                                                                                                        |      | 28   |      | A             |

(\*) Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %

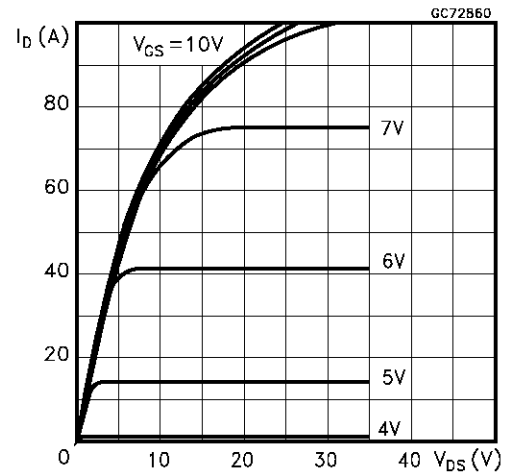
(•) Pulse width limited by safe operating area

**Safe Operating Area****Thermal Impedance**

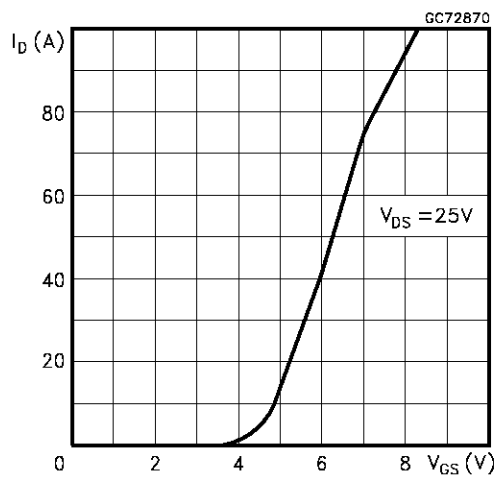
Derating Curve



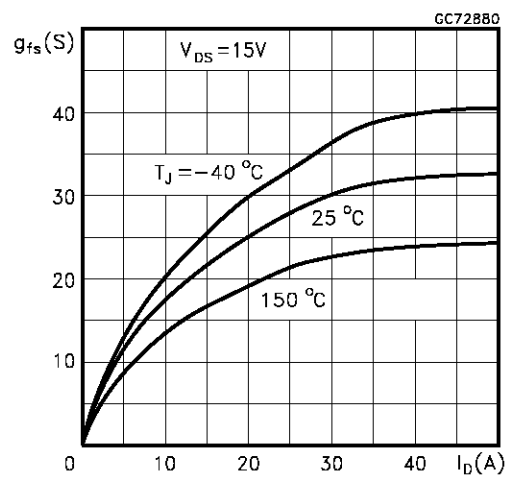
Output Characteristics



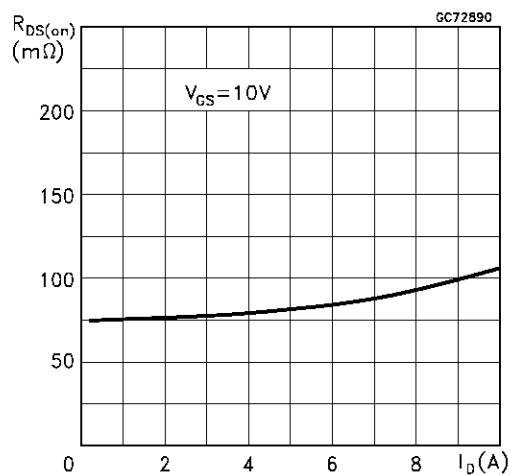
Transfer Characteristics



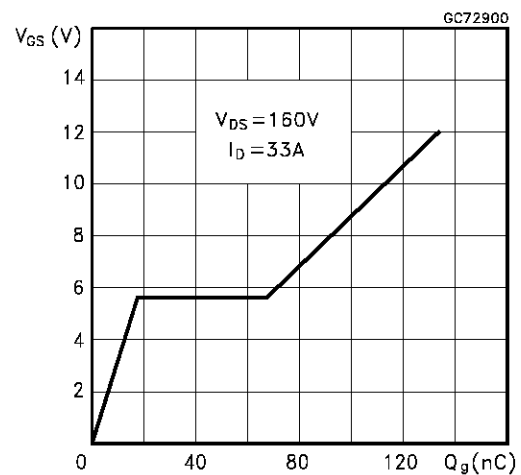
Transconductance



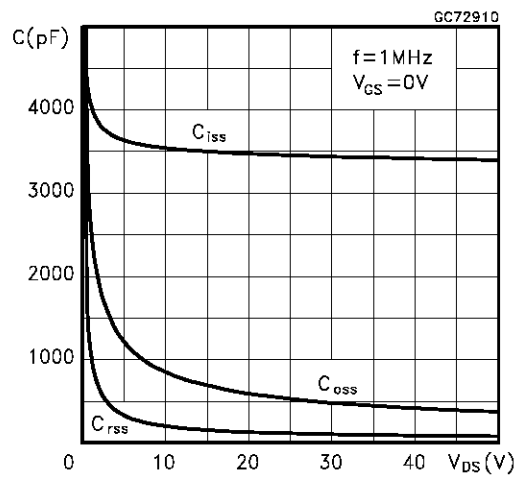
Static Drain-source On Resistance



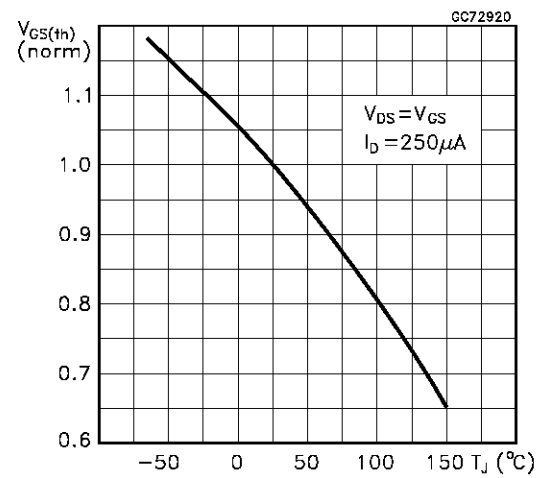
Gate Charge vs Gate-source Voltage



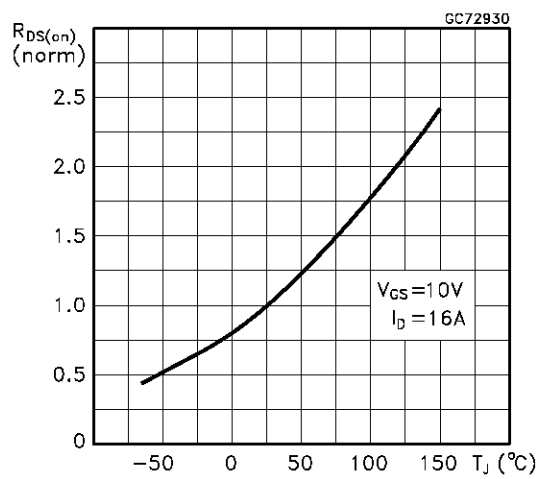
## Capacitance Variations



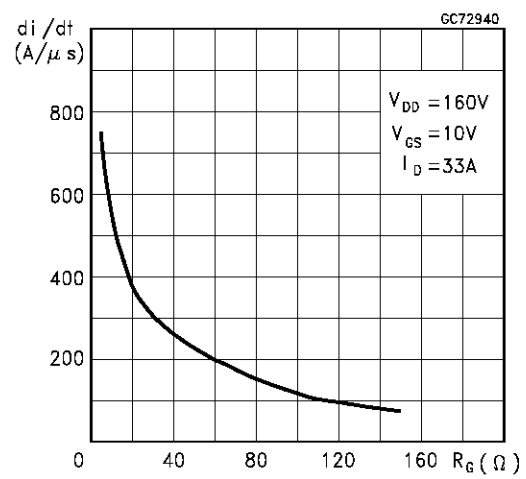
## Normalized Gate Threshold Voltage vs Temperature



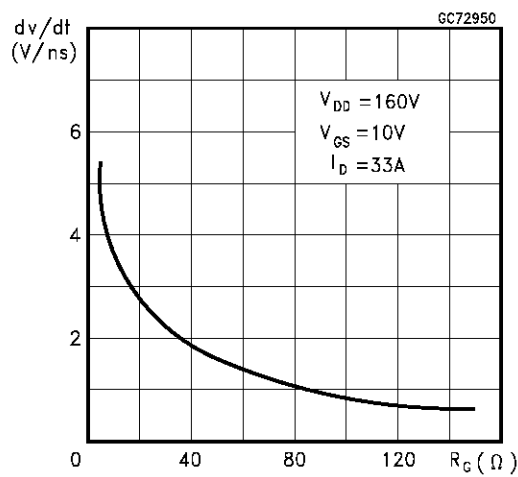
## Normalized On Resistance vs Temperature



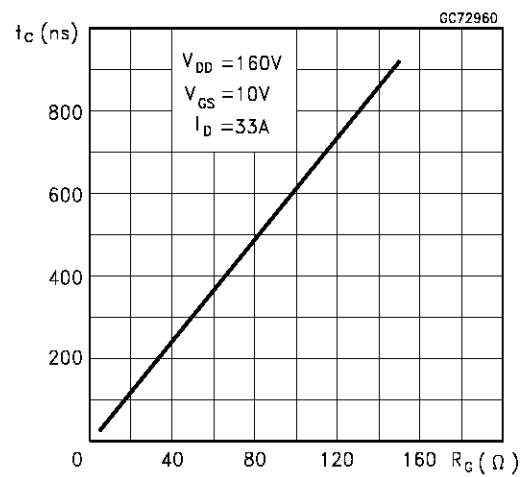
## Turn-on Current Slope



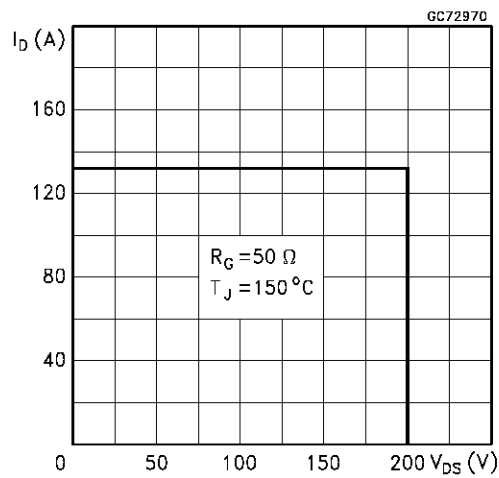
## Turn-off Drain-source Voltage Slope



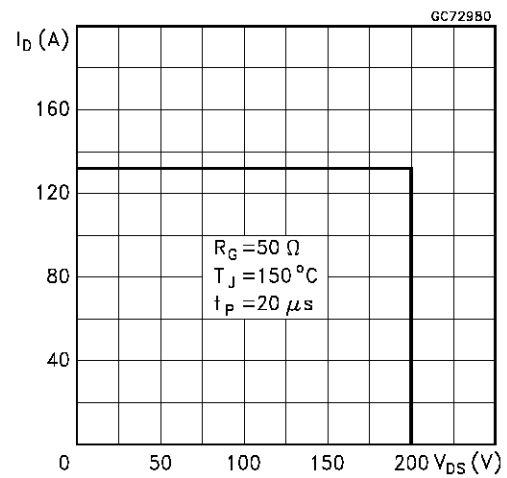
## Cross-over Time



Switching Safe Operating Area



Accidental Overload Area



Source-drain Diode Forward Characteristics

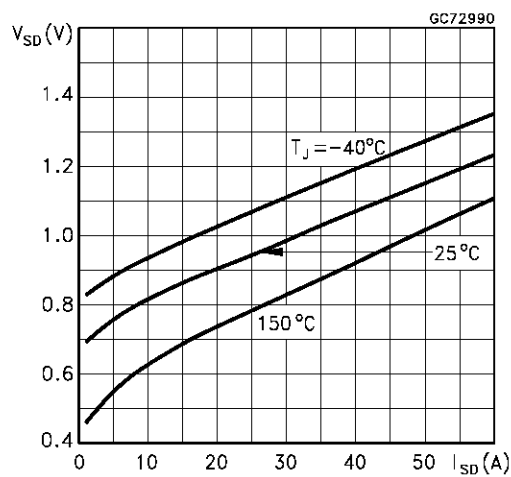
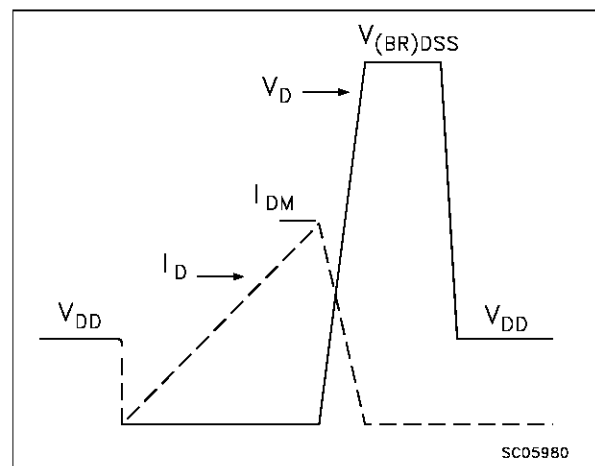
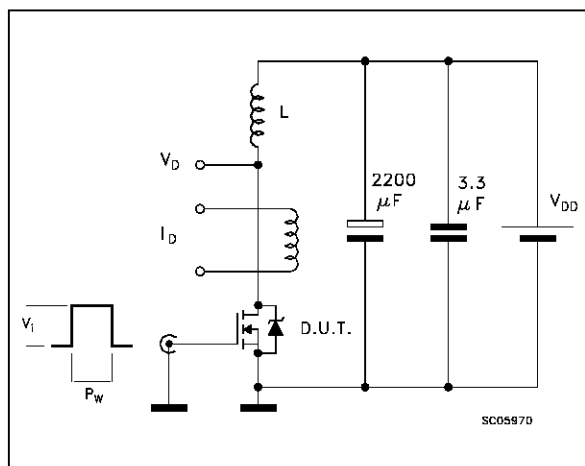
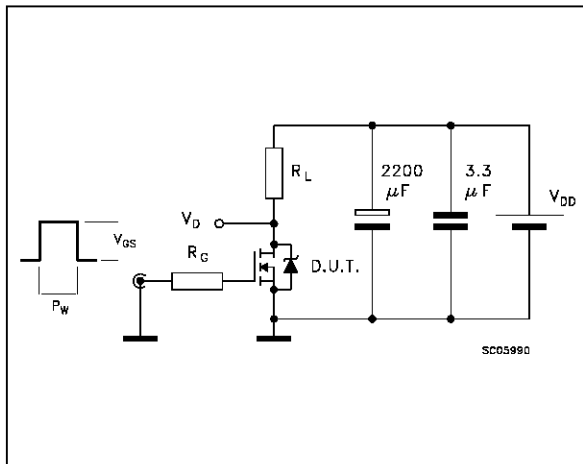


Fig. 1: Unclamped Inductive Load Test Circuit

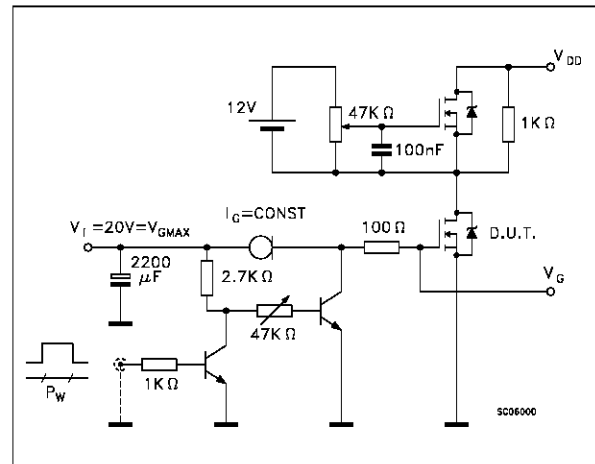
Fig. 2: Unclamped Inductive Waveform



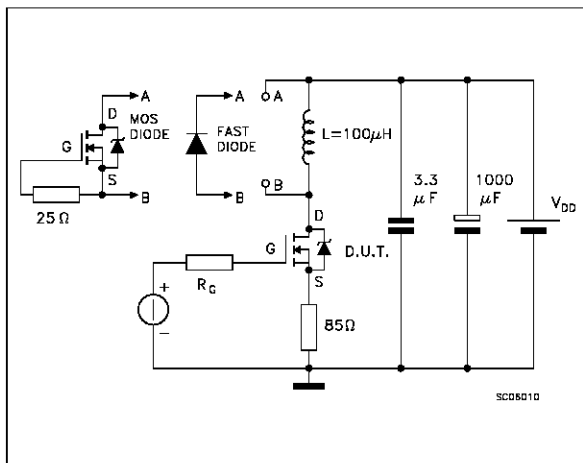
**Fig. 3: Switching Times Test Circuits For Resistive Load**



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



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







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