

## N - CHANNEL ENHANCEMENT MODE FAST POWER MOS TRANSISTOR

| TYPE        | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-------------|------------------|---------------------|----------------|
| STH12NA60   | 600 V            | < 0.6 Ω             | 12 A           |
| STH12NA60FI | 600 V            | < 0.6 Ω             | 7 A            |
| STW12NA60   | 600 V            | < 0.6 Ω             | 12 A           |

- TYPICAL R<sub>DS(on)</sub> = 0.44 Ω
- ± 30V GATE TO SOURCE VOLTAGE RATING
- 100% AVALANCHE TESTED
- REPETITIVE AVALANCHE DATA AT 100°C
- LOW INTRINSIC CAPACITANCES
- GATE CHARGE MINIMIZED
- REDUCED THRESHOLD VOLTAGE SPREAD

### DESCRIPTION

This series of POWER MOSFETS represents the most advanced high voltage technology. The optimized cell layout coupled with a new proprietary edge termination concur to give the device low R<sub>DS(on)</sub> and gate charge, unequalled ruggedness and superior switching performance.

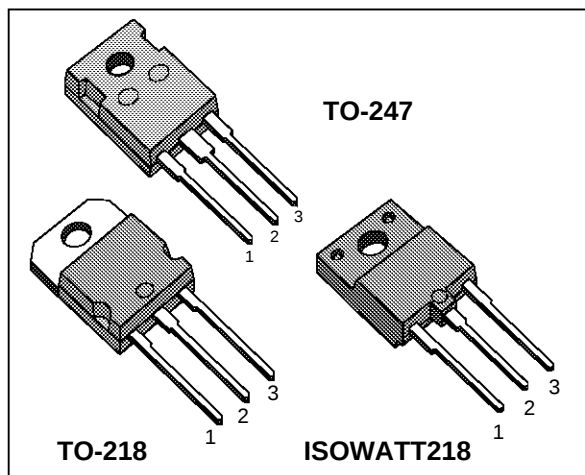
### APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- SWITCH MODE POWER SUPPLIES (SMPS)
- DC-AC CONVERTERS FOR WELDING EQUIPMENT AND UNINTERRUPTIBLE POWER SUPPLIES AND MOTOR DRIVE

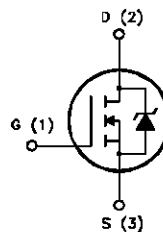
### ABSOLUTE MAXIMUM RATINGS

| Symbol              | Parameter                                             | Value         |             | Unit |
|---------------------|-------------------------------------------------------|---------------|-------------|------|
|                     |                                                       | STH/STW12NA60 | STH12NA60FI |      |
| V <sub>DS</sub>     | Drain-source Voltage (V <sub>GS</sub> = 0)            | 600           |             | V    |
| V <sub>DGR</sub>    | Drain- gate Voltage (R <sub>GS</sub> = 20 kΩ)         | 600           |             | V    |
| V <sub>GS</sub>     | Gate-source Voltage                                   | ± 30          |             | V    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 25 °C  | 12            | 7           | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 100 °C | 7.6           | 4.4         | A    |
| I <sub>DM</sub> (•) | Drain Current (pulsed)                                | 48            | 48          | A    |
| P <sub>tot</sub>    | Total Dissipation at T <sub>c</sub> = 25 °C           | 190           | 80          | W    |
|                     | Derating Factor                                       | 1.52          | 0.64        | W/°C |
| V <sub>ISO</sub>    | Insulation Withstand Voltage (DC)                     | —             | 4000        | V    |
| 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



### INTERNAL SCHEMATIC DIAGRAM



**THERMAL DATA**

|                       |                                                | TO-218/TO-247 | ISOWATT218 |      |
|-----------------------|------------------------------------------------|---------------|------------|------|
| R <sub>thj-case</sub> | Thermal Resistance Junction-case Max           | 0.66          | 1.56       | °C/W |
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient Max        | 30            |            | °C/W |
| R <sub>thc-sink</sub> | Thermal Resistance Case-sink Typ               | 0.1           |            | °C/W |
| T <sub>l</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, δ < 1%)                          | 12        | 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)   | 700       | mJ   |
| E <sub>AR</sub> | Repetitive Avalanche Energy (pulse width limited by T <sub>j</sub> max, δ < 1%)                                              | 28        | mJ   |
| I <sub>AR</sub> | Avalanche Current, Repetitive or Not-Repetitive (T <sub>c</sub> = 100 °C, pulse width limited by T <sub>j</sub> max, δ < 1%) | 7.6       | A    |

**ELECTRICAL CHARACTERISTICS** (T<sub>case</sub> = 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                                                | 600  |      |           | 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 x 0.8 T <sub>c</sub> = 125 °C |      |      | 25<br>250 | μA<br>μA |
| I <sub>GSS</sub>     | Gate-body Leakage Current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ± 30 V                                                                   |      |      | ± 100     | nA       |

**ON (\*)**

| 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> = 250 μA                               | 2.25 | 3    | 3.75 | V    |
| R <sub>DS(on)</sub> | Static Drain-source On Resistance | V <sub>GS</sub> = 10V I <sub>D</sub> = 6 A                                              |      | 0.44 | 0.6  | Ω    |
| I <sub>D(on)</sub>  | On State Drain Current            | V <sub>DS</sub> > I <sub>D(on)</sub> x R <sub>DS(on)max</sub><br>V <sub>GS</sub> = 10 V | 12   |      |      | A    |

**DYNAMIC**

| Symbol              | Parameter                    | Test Conditions                                                                    | Min. | Typ. | Max. | Unit |
|---------------------|------------------------------|------------------------------------------------------------------------------------|------|------|------|------|
| g <sub>fs</sub> (*) | Forward Transconductance     | V <sub>DS</sub> > I <sub>D(on)</sub> x R <sub>DS(on)max</sub> I <sub>D</sub> = 6 A | 8    | 12   |      | S    |
| C <sub>iss</sub>    | Input Capacitance            | V <sub>DS</sub> = 25 V f = 1 MHz V <sub>GS</sub> = 0                               |      | 2500 | 3250 | pF   |
| C <sub>oss</sub>    | Output Capacitance           |                                                                                    |      | 310  | 410  | pF   |
| C <sub>rss</sub>    | Reverse Transfer Capacitance |                                                                                    |      | 85   | 110  | pF   |

# ELECTRICAL CHARACTERISTICS (continued)

## SWITCHING ON

| Symbol                        | Parameter                                                    | Test Conditions                                                                                                          | Min. | Typ.            | Max.     | Unit           |
|-------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|-----------------|----------|----------------|
| $t_{d(on)}$<br>$t_r$          | Turn-on Time<br>Rise Time                                    | $V_{DD} = 300\text{ V}$ $I_D = 6\text{ A}$<br>$R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 3) |      | 25<br>35        | 35<br>50 | ns<br>ns       |
| $(di/dt)_{on}$                | Turn-on Current Slope                                        | $V_{DD} = 480\text{ V}$ $I_D = 12\text{ A}$<br>$R_G = 47\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 5) |      | 190             |          | A/ $\mu$ s     |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge | $V_{DD} = 480\text{ V}$ $I_D = 12\text{ A}$ $V_{GS} = 10\text{ V}$                                                       |      | 110<br>15<br>47 | 150      | 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 | $V_{DD} = 480\text{ V}$ $I_D = 12\text{ A}$<br>$R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 5) |      | 35<br>20<br>57 | 50<br>30<br>80 | ns<br>ns<br>ns |

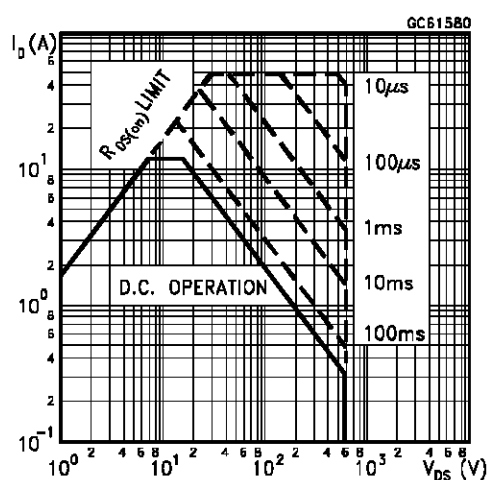
## SOURCE DRAIN DIODE

| Symbol                            | Parameter                                                                             | Test Conditions                                                                                                                                        | Min. | Typ.              | Max.     | Unit               |
|-----------------------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------|----------|--------------------|
| $I_{SD}$<br>$I_{SDM}(\bullet)$    | Source-drain Current<br>Source-drain Current<br>(pulsed)                              |                                                                                                                                                        |      |                   | 12<br>48 | A<br>A             |
| $V_{SD} (*)$                      | Forward On Voltage                                                                    | $I_{SD} = 12\text{ A}$ $V_{GS} = 0$                                                                                                                    |      |                   | 1.6      | V                  |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery<br>Time<br>Reverse Recovery<br>Charge<br>Reverse Recovery<br>Current | $I_{SD} = 12\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ $T_J = 150\text{ }^\circ\text{C}$<br>(see test circuit, figure 5) |      | 670<br>12.7<br>38 |          | ns<br>$\mu$ C<br>A |

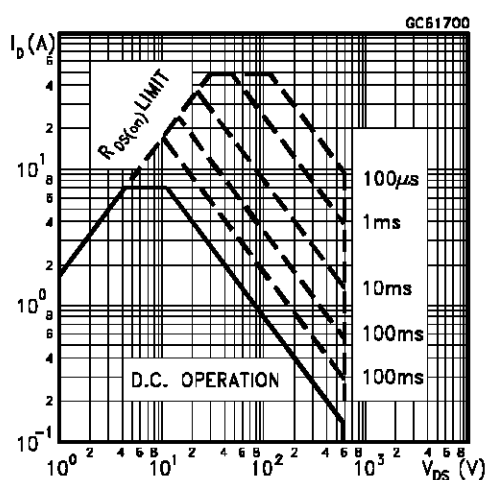
(\*) Pulsed: Pulse duration = 300  $\mu$ s, duty cycle 1.5 %

( $\bullet$ ) Pulse width limited by safe operating area

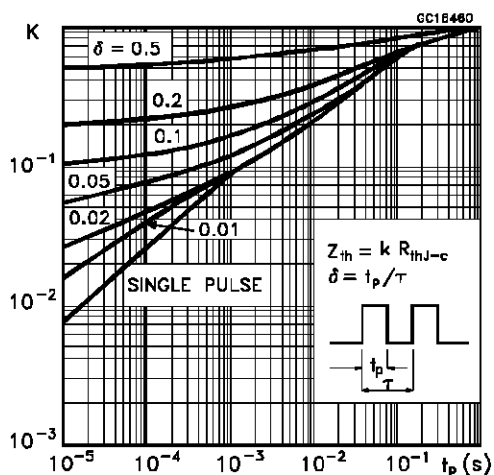
## Safe Operating Areas For TO-218 and TO-247



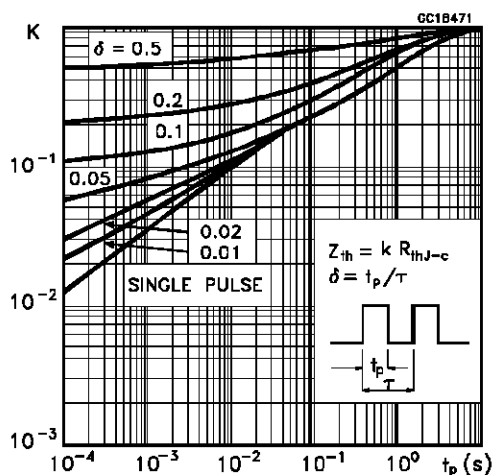
## Safe Operating Areas For ISOWATT218



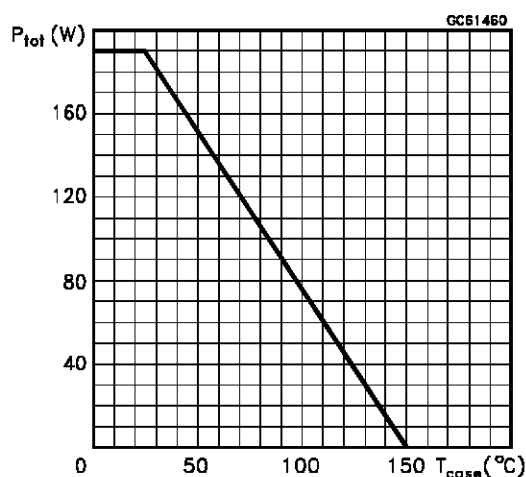
Thermal Impedance For TO-218 and TO-247



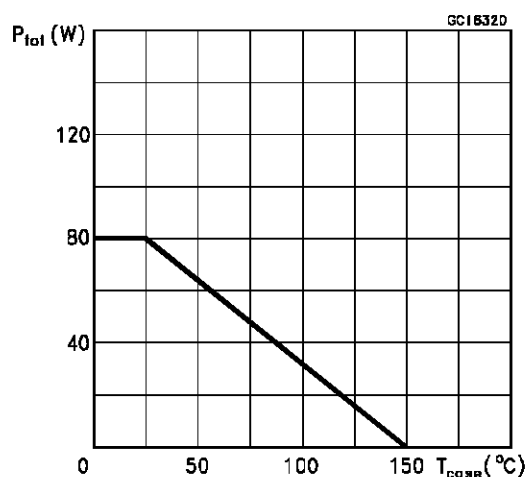
Thermal Impedance For ISOWATT218



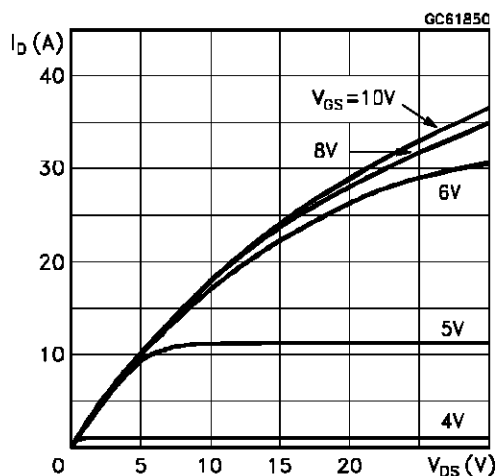
Derating Curve For TO-218 and TO-247



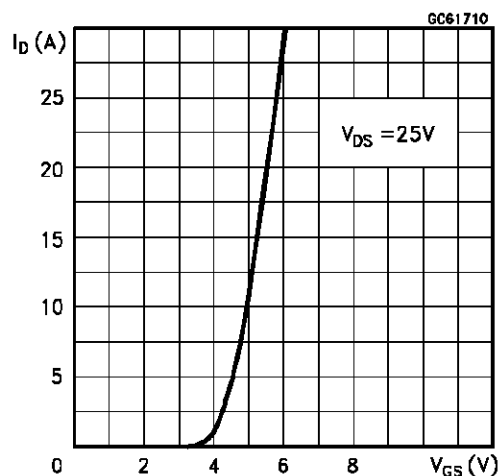
Derating Curve For ISOWATT218



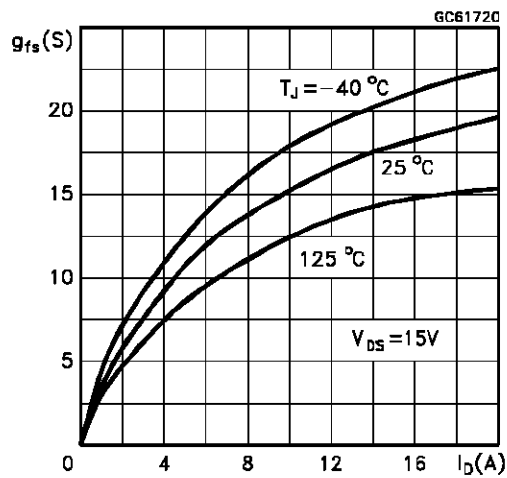
Output Characteristics



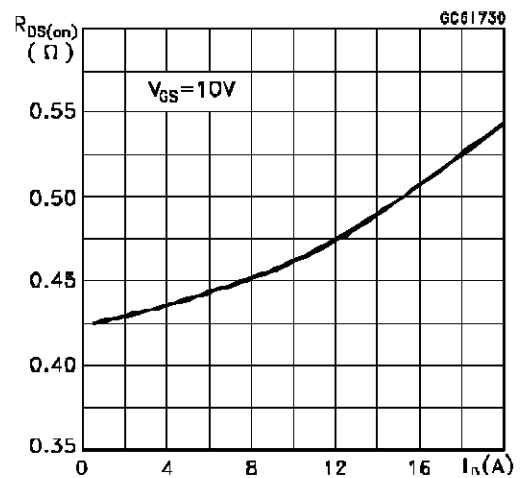
Transfer Characteristics



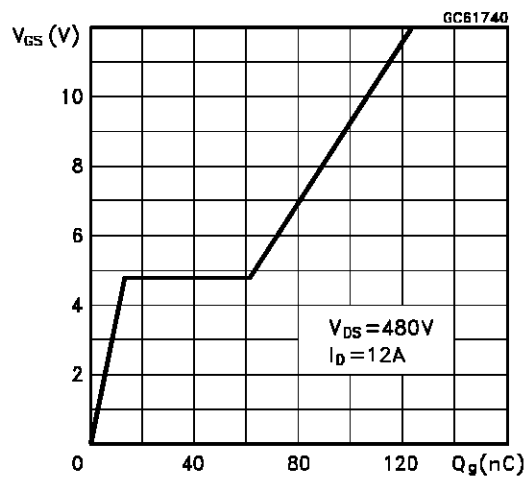
Transconductance



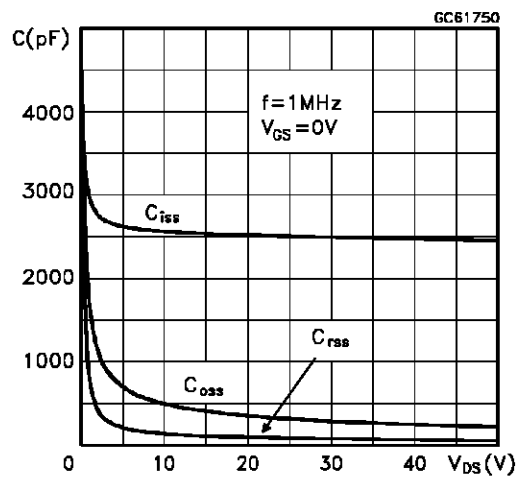
Static Drain-source On Resistance



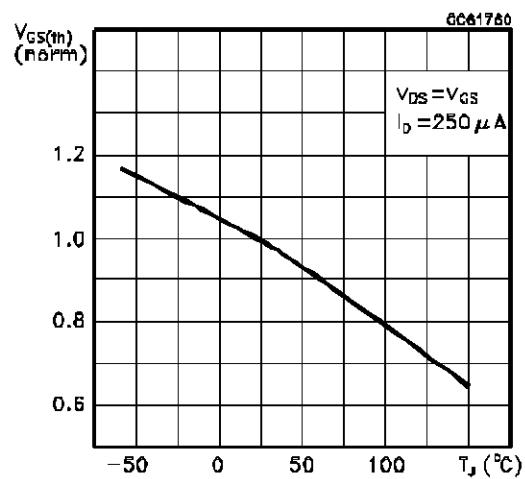
Gate Charge vs Gate-source Voltage



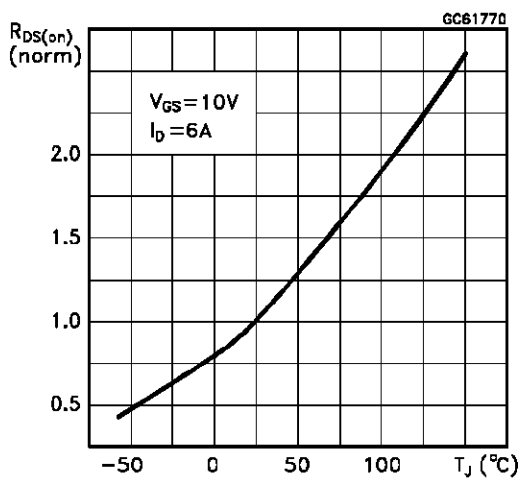
Capacitance Variations



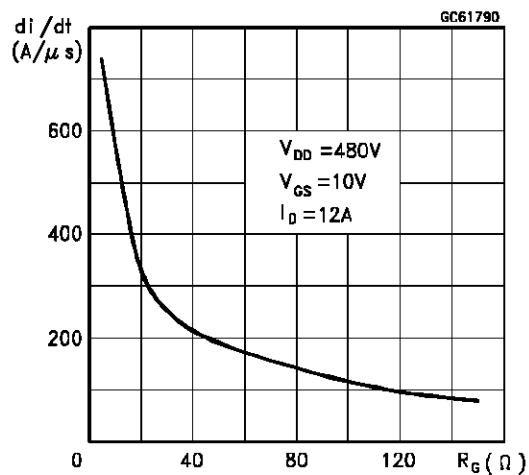
Normalized Gate Threshold Voltage vs Temperature



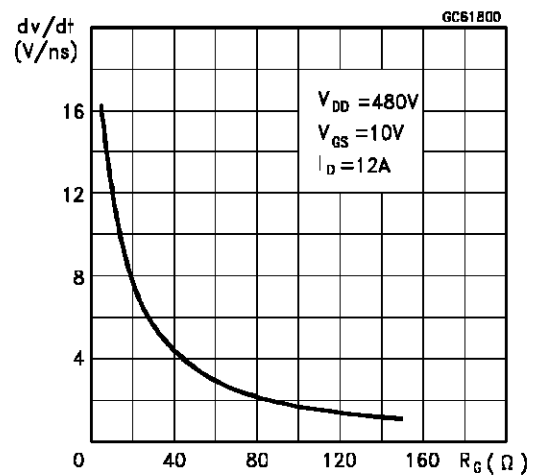
Normalized On Resistance vs Temperature



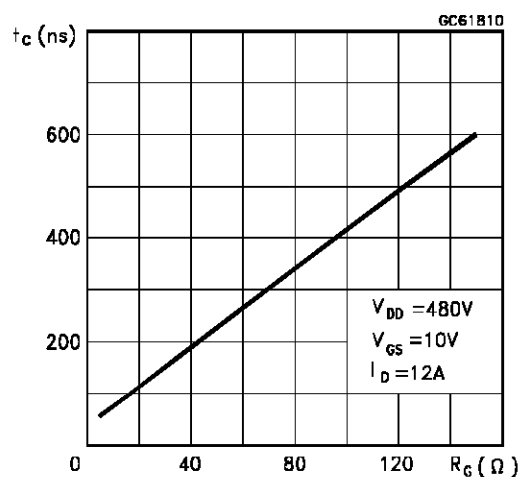
Turn-on Current Slope



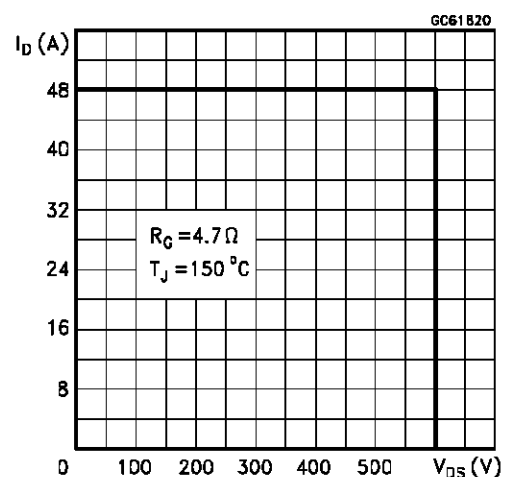
Turn-off Drain-source Voltage Slope



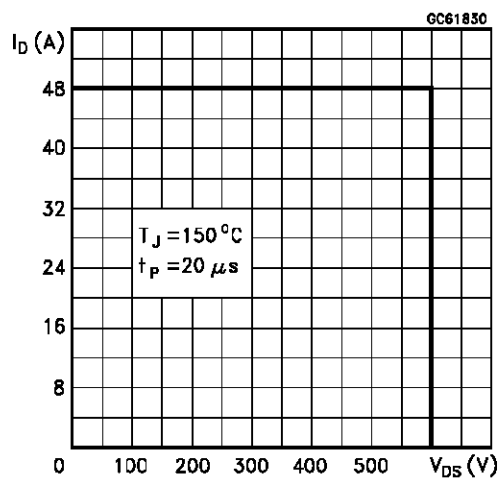
Cross-over Time



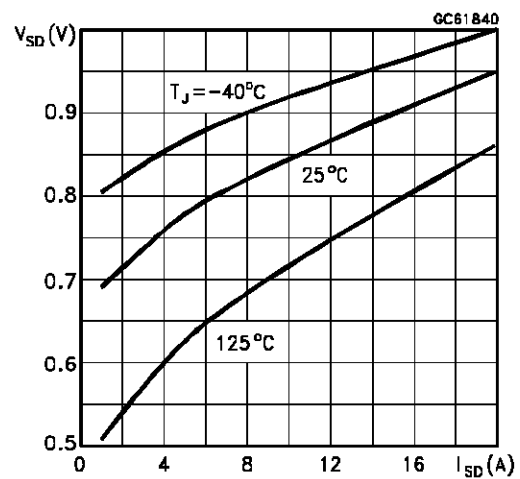
Switching Safe Operating Area



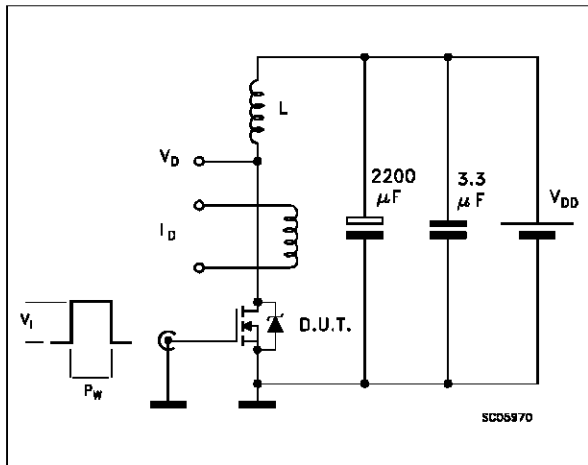
Accidental Overload Area



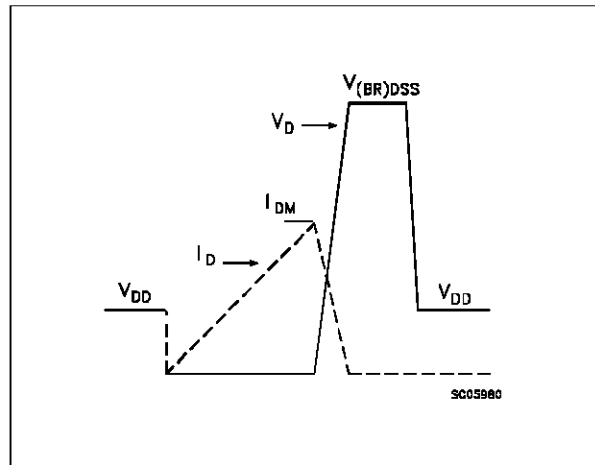
Source-drain Diode Forward Characteristics



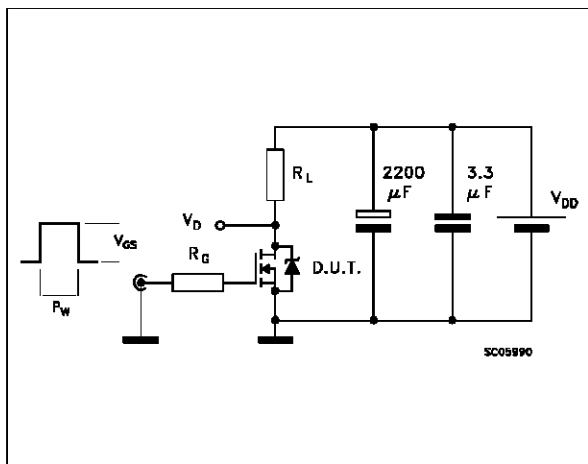
**Fig. 1:** Unclamped Inductive Load Test Circuits



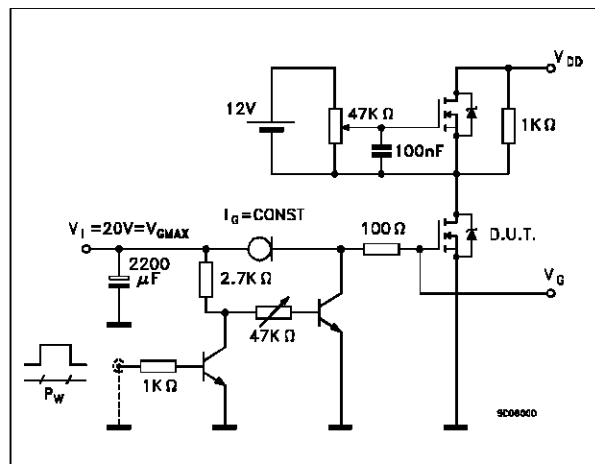
**Fig. 2:** Unclamped Inductive Waveforms



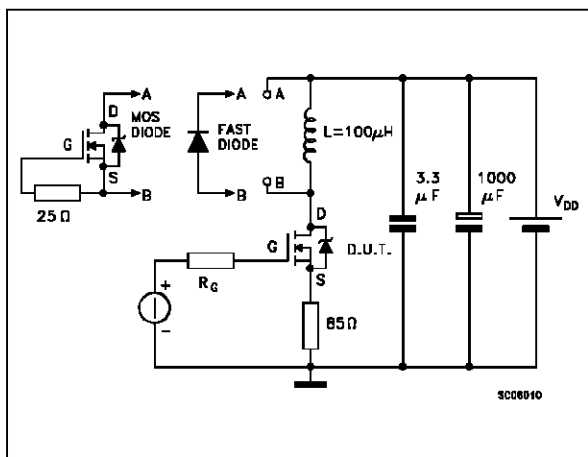
**Fig. 3:** Switching Times Test Circuits For Resistive Load



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

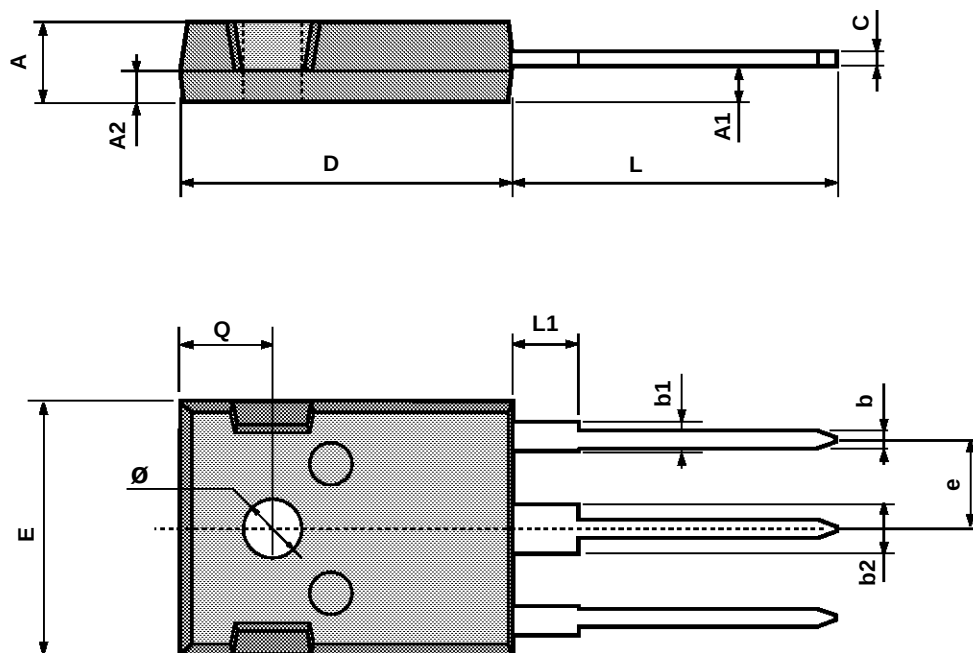


**Fig. 5:** Test Circuit For Inductive Load Switching And Diode Reverse Recovery Time



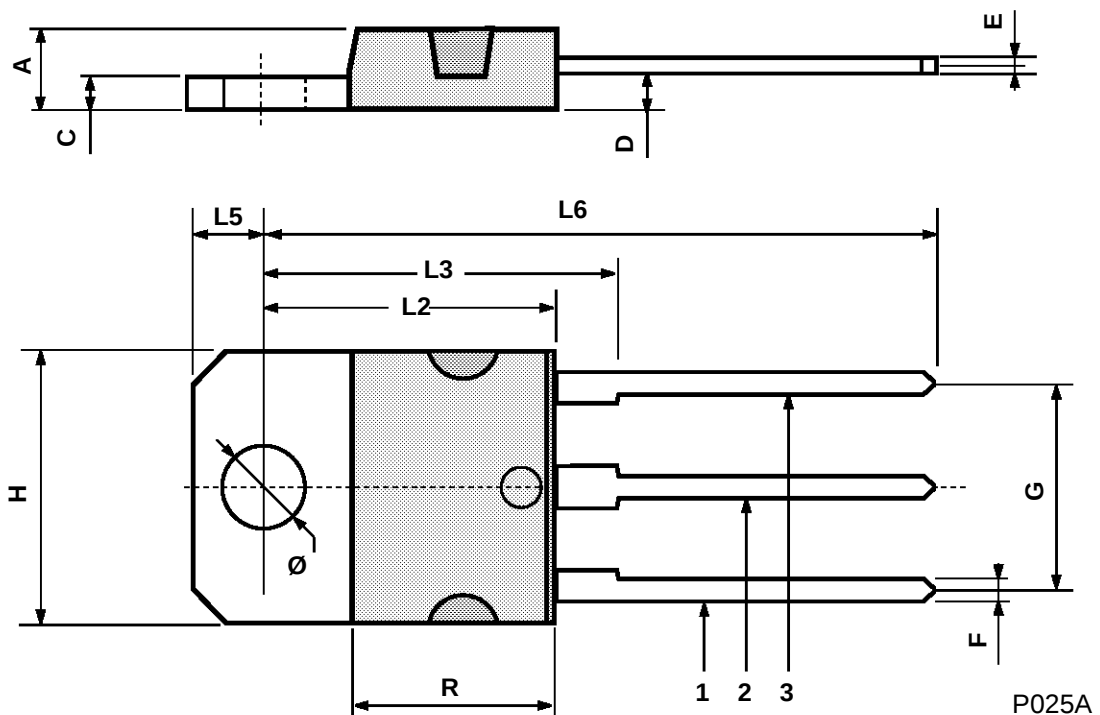
TO-247 MECHANICAL DATA

| DIM. | mm    |      |       | inch  |      |       |
|------|-------|------|-------|-------|------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP. | MAX.  |
| A    | 4.7   |      | 5.3   | 0.185 |      | 0.208 |
| A1   |       |      | 2.87  |       |      | 0.113 |
| A2   | 1.5   |      | 2.5   | 0.059 |      | 0.098 |
| b    | 1     |      | 1.4   | 0.039 |      | 0.055 |
| b1   |       |      | 2.25  |       |      | 0.088 |
| b2   | 3.05  |      | 3.43  | 0.120 |      | 0.135 |
| C    | 0.4   |      | 0.8   | 0.015 |      | 0.031 |
| D    | 20.4  |      | 21.18 | 0.803 |      | 0.833 |
| e    | 5.43  |      | 5.47  | 0.213 |      | 0.215 |
| E    | 15.3  |      | 15.95 | 0.602 |      | 0.628 |
| L    | 15.57 |      |       | 0.613 |      |       |
| L1   | 3.7   |      | 4.3   | 0.145 |      | 0.169 |
| Q    | 5.3   |      | 5.84  | 0.208 |      | 0.230 |
| ØP   | 3.5   |      | 3.71  | 0.137 |      | 0.146 |



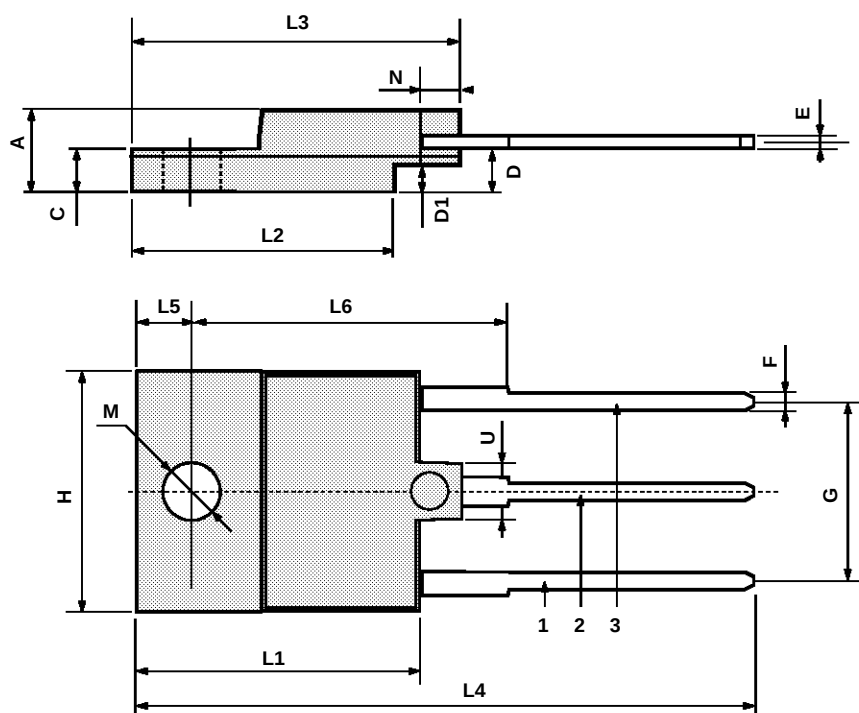
TO-218 (SOT-93) MECHANICAL DATA

| DIM. | mm   |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.7  |      | 4.9  | 0.185 |       | 0.193 |
| C    | 1.17 |      | 1.37 | 0.046 |       | 0.054 |
| D    |      | 2.5  |      |       | 0.098 |       |
| E    | 0.5  |      | 0.78 | 0.019 |       | 0.030 |
| F    | 1.1  |      | 1.3  | 0.043 |       | 0.051 |
| G    | 10.8 |      | 11.1 | 0.425 |       | 0.437 |
| H    | 14.7 |      | 15.2 | 0.578 |       | 0.598 |
| L2   | –    |      | 16.2 | –     |       | 0.637 |
| L3   |      | 18   |      |       | 0.708 |       |
| L5   | 3.95 |      | 4.15 | 0.155 |       | 0.163 |
| L6   |      | 31   |      |       | 1.220 |       |
| R    | –    |      | 12.2 | –     |       | 0.480 |
| Ø    | 4    |      | 4.1  | 0.157 |       | 0.161 |



# ISOWATT218 MECHANICAL DATA

| DIM. | mm    |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 5.35  |      | 5.65  | 0.210 |       | 0.222 |
| C    | 3.3   |      | 3.8   | 0.130 |       | 0.149 |
| D    | 2.9   |      | 3.1   | 0.114 |       | 0.122 |
| D1   | 1.88  |      | 2.08  | 0.074 |       | 0.081 |
| E    | 0.45  |      | 1     | 0.017 |       | 0.039 |
| F    | 1.05  |      | 1.25  | 0.041 |       | 0.049 |
| G    | 10.8  |      | 11.2  | 0.425 |       | 0.441 |
| H    | 15.8  |      | 16.2  | 0.622 |       | 0.637 |
| L1   | 20.8  |      | 21.2  | 0.818 |       | 0.834 |
| L2   | 19.1  |      | 19.9  | 0.752 |       | 0.783 |
| L3   | 22.8  |      | 23.6  | 0.897 |       | 0.929 |
| L4   | 40.5  |      | 42.5  | 1.594 |       | 1.673 |
| L5   | 4.85  |      | 5.25  | 0.190 |       | 0.206 |
| L6   | 20.25 |      | 20.75 | 0.797 |       | 0.817 |
| M    | 3.5   |      | 3.7   | 0.137 |       | 0.145 |
| N    | 2.1   |      | 2.3   | 0.082 |       | 0.090 |
| U    |       | 4.6  |       |       | 0.181 |       |



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