

**RADIATION HARDENED  
POWER MOSFET  
SURFACE MOUNT (SMD-1)**

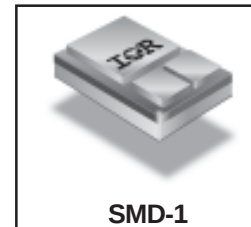
**IRHN7450  
JANSR2N7270U  
500V, N-CHANNEL**

REF: MIL-PRF-19500/603

**RAD-Hard™ HEXFET® TECHNOLOGY**

**Product Summary**

| Part Number | Radiation Level | RDS(on) | Id  | QPL Part Number |
|-------------|-----------------|---------|-----|-----------------|
| IRHN7450    | 100K Rads (Si)  | 0.45Ω   | 11A | JANSR2N7270U    |
| IRHN3450    | 300K Rads (Si)  | 0.45Ω   | 11A | JANSF2N7270U    |
| IRHN4450    | 500K Rads (Si)  | 0.45Ω   | 11A | JANSG2N7270U    |
| IRHN8450    | 1000K Rads (Si) | 0.45Ω   | 11A | JANSH2N7270U    |



International Rectifier's RAD-Hard™ HEXFET® technology provides high performance power MOSFETs for space applications. This technology has over a decade of proven performance and reliability in satellite applications. These devices have been characterized for both Total Dose and Single Event Effects (SEE). The combination of low Rdson and low gate charge reduces the power losses in switching applications such as DC to DC converters and motor control. These devices retain all of the well established advantages of MOSFETs such as voltage control, fast switching, ease of paralleling and temperature stability of electrical parameters.

**Features:**

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Surface Mount
- Ceramic Package
- Light Weight

**Absolute Maximum Ratings**

**Pre-Irradiation**

|                            | Parameter                       |               | Units |
|----------------------------|---------------------------------|---------------|-------|
| Id @ VGS = 12V, TC = 25°C  | Continuous Drain Current        | 11            | A     |
| Id @ VGS = 12V, TC = 100°C | Continuous Drain Current        | 7.0           |       |
| IDM                        | Pulsed Drain Current ①          | 44            |       |
| PD @ TC = 25°C             | Max. Power Dissipation          | 150           | W     |
|                            | Linear Derating Factor          | 1.2           | W/°C  |
| VGS                        | Gate-to-Source Voltage          | ±20           | V     |
| EAS                        | Single Pulse Avalanche Energy ② | 500           | mJ    |
| IAR                        | Avalanche Current ①             | 11            | A     |
| EAR                        | Repetitive Avalanche Energy ①   | 15            | mJ    |
| dv/dt                      | Peak Diode Recovery dv/dt ③     | 3.5           | V/ns  |
| TJ                         | Operating Junction              | -55 to 150    | °C    |
| TSTG                       | Storage Temperature Range       |               |       |
|                            | PCKG. Mounting Surface Temp.    | 300 (for 5s)  |       |
|                            | Weight                          | 2.6 (Typical) | g     |

For footnotes refer to the last page

**Electrical Characteristics @ T<sub>j</sub> = 25°C (Unless Otherwise Specified)**

|                                     | Parameter                                    | Min | Typ  | Max          | Units | Test Conditions                                                                                                        |
|-------------------------------------|----------------------------------------------|-----|------|--------------|-------|------------------------------------------------------------------------------------------------------------------------|
| BV <sub>DSS</sub>                   | Drain-to-Source Breakdown Voltage            | 500 | —    | —            | V     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1.0mA                                                                          |
| ΔBV <sub>DSS</sub> /ΔT <sub>j</sub> | Temperature Coefficient of Breakdown Voltage | —   | 0.6  | —            | V/°C  | Reference to 25°C, I <sub>D</sub> = 1.0mA                                                                              |
| R <sub>DS(on)</sub>                 | Static Drain-to-Source On-State Resistance   | —   | —    | 0.45<br>0.50 | Ω     | V <sub>GS</sub> = 12V, I <sub>D</sub> = 7.0A ④<br>V <sub>GS</sub> = 12V, I <sub>D</sub> = 11A                          |
| V <sub>GS(th)</sub>                 | Gate Threshold Voltage                       | 2.0 | —    | 4.0          | V     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1.0mA                                                             |
| g <sub>fs</sub>                     | Forward Transconductance                     | 4.0 | —    | —            | S (℧) | V <sub>DS</sub> > 15V, I <sub>DS</sub> = 7.0A ④                                                                        |
| I <sub>DSS</sub>                    | Zero Gate Voltage Drain Current              | —   | —    | 50<br>250    | μA    | V <sub>DS</sub> = 400V, V <sub>GS</sub> = 0V<br>V <sub>DS</sub> = 400V<br>V <sub>GS</sub> = 0V, T <sub>j</sub> = 125°C |
| I <sub>GSS</sub>                    | Gate-to-Source Leakage Forward               | —   | —    | 100          | nA    | V <sub>GS</sub> = 20V                                                                                                  |
| I <sub>GSS</sub>                    | Gate-to-Source Leakage Reverse               | —   | —    | -100         | nA    | V <sub>GS</sub> = -20V                                                                                                 |
| Q <sub>g</sub>                      | Total Gate Charge                            | —   | —    | 150          | nC    | V <sub>GS</sub> = 12V, I <sub>D</sub> = 11A<br>V <sub>DS</sub> = 250V                                                  |
| Q <sub>gs</sub>                     | Gate-to-Source Charge                        | —   | —    | 30           | nC    |                                                                                                                        |
| Q <sub>gd</sub>                     | Gate-to-Drain ('Miller') Charge              | —   | —    | 75           | nC    |                                                                                                                        |
| t <sub>d(on)</sub>                  | Turn-On Delay Time                           | —   | —    | 45           | ns    | V <sub>DD</sub> = 250V, I <sub>D</sub> = 11A,<br>V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω                         |
| t <sub>r</sub>                      | Rise Time                                    | —   | —    | 190          |       |                                                                                                                        |
| t <sub>d(off)</sub>                 | Turn-Off Delay Time                          | —   | —    | 190          |       |                                                                                                                        |
| t <sub>f</sub>                      | Fall Time                                    | —   | —    | 130          |       |                                                                                                                        |
| L <sub>S</sub> + L <sub>D</sub>     | Total Inductance                             | —   | 4.0  | —            | nH    | Measured from the center of drain pad to center of source pad                                                          |
| C <sub>iss</sub>                    | Input Capacitance                            | —   | 4000 | —            | pF    | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V<br>f = 1.0MHz                                                              |
| C <sub>oss</sub>                    | Output Capacitance                           | —   | 330  | —            |       |                                                                                                                        |
| C <sub>rss</sub>                    | Reverse Transfer Capacitance                 | —   | 52   | —            |       |                                                                                                                        |

**Source-Drain Diode Ratings and Characteristics**

|                 | Parameter                              | Min                                                                                                                  | Typ | Max  | Units | Test Conditions                                                                         |
|-----------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----|------|-------|-----------------------------------------------------------------------------------------|
| I <sub>S</sub>  | Continuous Source Current (Body Diode) | —                                                                                                                    | —   | 11   | A     |                                                                                         |
| I <sub>SM</sub> | Pulse Source Current (Body Diode) ①    | —                                                                                                                    | —   | 44   |       |                                                                                         |
| V <sub>SD</sub> | Diode Forward Voltage                  | —                                                                                                                    | —   | 1.6  | V     | T <sub>j</sub> = 25°C, I <sub>S</sub> = 11A, V <sub>GS</sub> = 0V ④                     |
| t <sub>rr</sub> | Reverse Recovery Time                  | —                                                                                                                    | —   | 1100 | ns    | T <sub>j</sub> = 25°C, I <sub>F</sub> = 11A, di/dt ≥ 100A/μs<br>V <sub>DD</sub> ≤ 50V ④ |
| Q <sub>RR</sub> | Reverse Recovery Charge                | —                                                                                                                    | —   | 16   | μC    |                                                                                         |
| t <sub>on</sub> | Forward Turn-On Time                   | Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L <sub>S</sub> + L <sub>D</sub> . |     |      |       |                                                                                         |

**Thermal Resistance**

|                      | Parameter            | Min | Typ | Max  | Units | Test Conditions                       |
|----------------------|----------------------|-----|-----|------|-------|---------------------------------------|
| R <sub>thJC</sub>    | Junction-to-Case     | —   | —   | 0.83 | °C/W  | soldered to a 1"sq. copper-clad board |
| R <sub>thJ-PCB</sub> | Junction-to-PC board | —   | 6.6 | —    |       |                                       |

Note: Corresponding Spice and Saber models are available on the International Rectifier Website.

For footnotes refer to the last page

## Radiation Characteristics

## IRHN7450, JANSR2N7270U

International Rectifier Radiation Hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at International Rectifier is comprised of two radiation environments. Every manufacturing lot is tested for total ionizing dose (per notes 5 and 6) using the TO-3 package. Both pre- and post-irradiation performance are tested and specified using the same drive circuitry and test conditions in order to provide a direct comparison.

**Table 1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation** ⑤⑥

|                     | Parameter                                               | 100K Rads(Si) <sup>1</sup> |      | 300K- 1000K Rads (Si) <sup>2</sup> |      | Units | Test Conditions                                             |
|---------------------|---------------------------------------------------------|----------------------------|------|------------------------------------|------|-------|-------------------------------------------------------------|
|                     |                                                         | Min                        | Max  | Min                                | Max  |       |                                                             |
| BV <sub>DSS</sub>   | Drain-to-Source Breakdown Voltage                       | 500                        | —    | 500                                | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA                |
| V <sub>GS(th)</sub> | Gate Threshold Voltage                                  | 2.0                        | 4.0  | 1.25                               | 4.5  |       | V <sub>GS</sub> = V <sub>DSS</sub> , I <sub>D</sub> = 1.0mA |
| I <sub>GSS</sub>    | Gate-to-Source Leakage Forward                          | —                          | 100  | —                                  | 100  | nA    | V <sub>GS</sub> = 20V                                       |
| I <sub>GSS</sub>    | Gate-to-Source Leakage Reverse                          | —                          | -100 | —                                  | -100 |       | V <sub>GS</sub> = -20 V                                     |
| I <sub>DSS</sub>    | Zero Gate Voltage Drain Current                         | —                          | 50   | —                                  | 50   | μA    | V <sub>DSS</sub> =400V, V <sub>GS</sub> = 0V                |
| R <sub>DS(on)</sub> | Static Drain-to-Source ④<br>On-State Resistance (TO-3)  | —                          | 0.45 | —                                  | 0.6  | Ω     | V <sub>GS</sub> = 12V, I <sub>D</sub> = 7.0A                |
| R <sub>DS(on)</sub> | Static Drain-to-Source ④<br>On-State Resistance (SMD-1) | —                          | 0.45 | —                                  | 0.6  | Ω     | V <sub>GS</sub> = 12V, I <sub>D</sub> = 7.0A                |
| V <sub>SD</sub>     | Diode Forward Voltage ④                                 | —                          | 1.6  | —                                  | 1.6  | V     | V <sub>GS</sub> = 0V, I <sub>S</sub> = 11A                  |

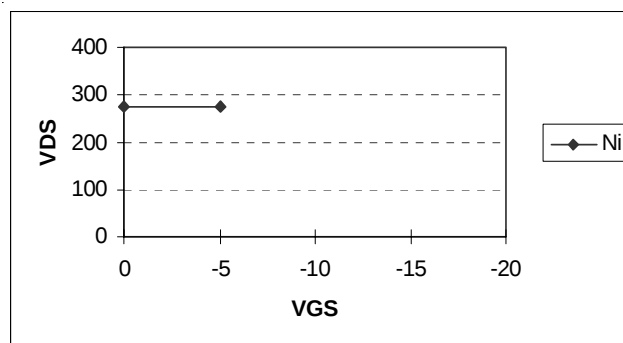
1. Part number IRHN7450 (JANSR2N7270U)

2. Part numbers IRHN3450 (JANSF2N7270U), IRHN4450 (JANSR2N7270U) and IRHN8450 (JANSR2N7270U)

International Rectifier radiation hardened MOSFETs have been characterized in heavy ion environment for Single Event Effects (SEE). Single Event Effects characterization is illustrated in Fig. a and Table 2.

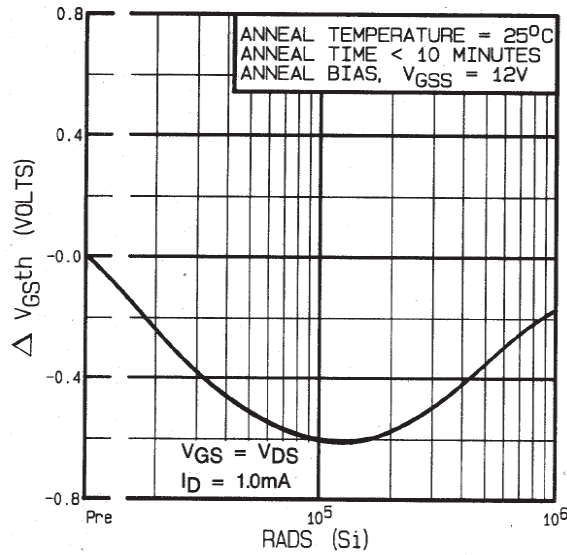
**Table 2. Single Event Effect Safe Operating Area**

| Ion | LET<br>(MeV/(mg/cm <sup>2</sup> )) | Energy<br>(MeV) | Range<br>(μm) | V <sub>DS</sub> (V)   |                        |                         |                         |                         |
|-----|------------------------------------|-----------------|---------------|-----------------------|------------------------|-------------------------|-------------------------|-------------------------|
|     |                                    |                 |               | @ V <sub>GS</sub> =0V | @ V <sub>GS</sub> =-5V | @ V <sub>GS</sub> =-10V | @ V <sub>GS</sub> =-15V | @ V <sub>GS</sub> =-20V |
| Ni  | 28                                 | 265             | 41            | 275                   | 275                    | -                       | -                       | -                       |

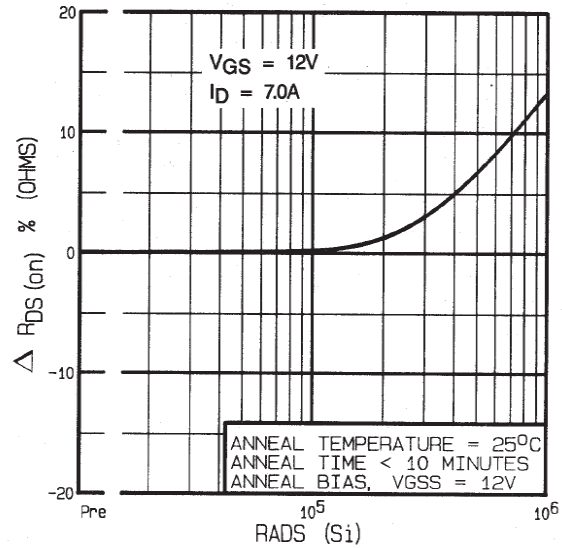


**Fig a. Single Event Effect, Safe Operating Area**

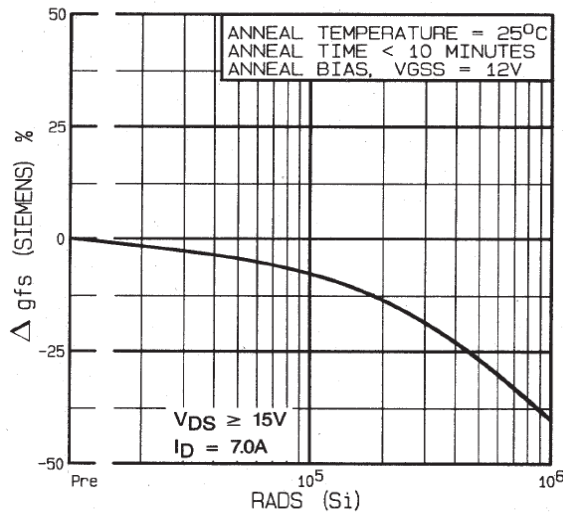
For footnotes refer to the last page



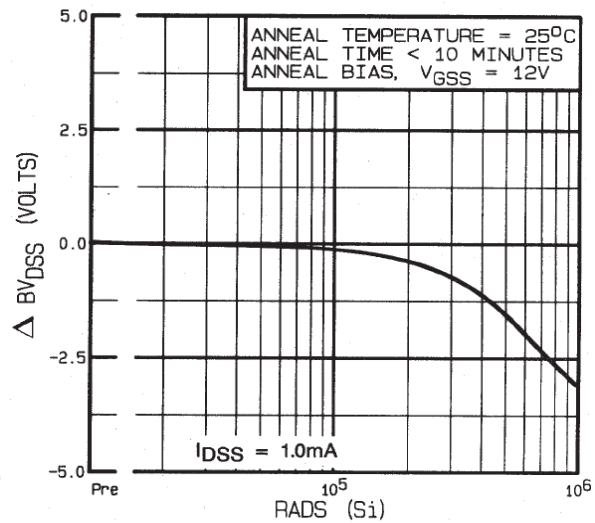
**Fig 1.** Typical Response of Gate Threshold Voltage Vs. Total Dose Exposure



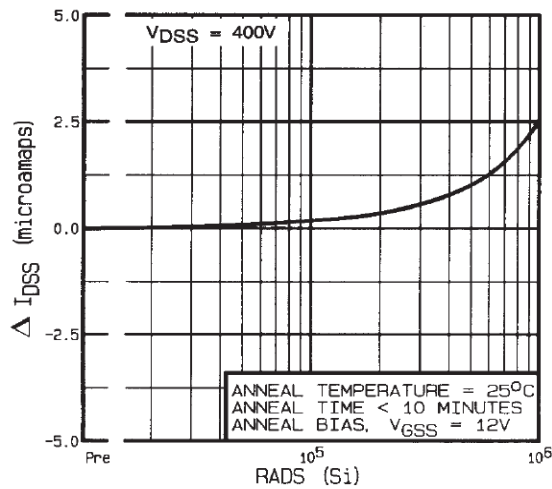
**Fig 2.** Typical Response of On-State Resistance Vs. Total Dose Exposure



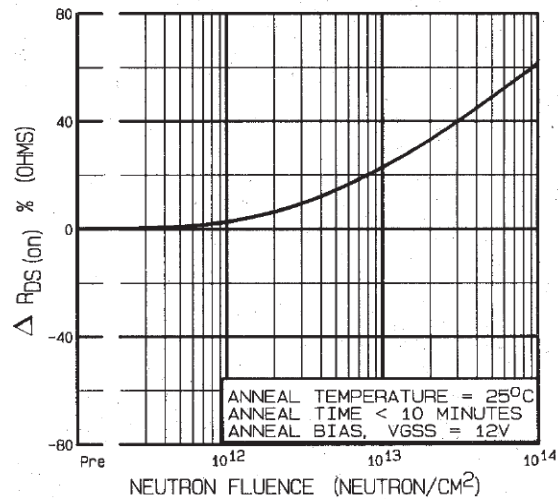
**Fig 3.** Typical Response of Transconductance Vs. Total Dose Exposure



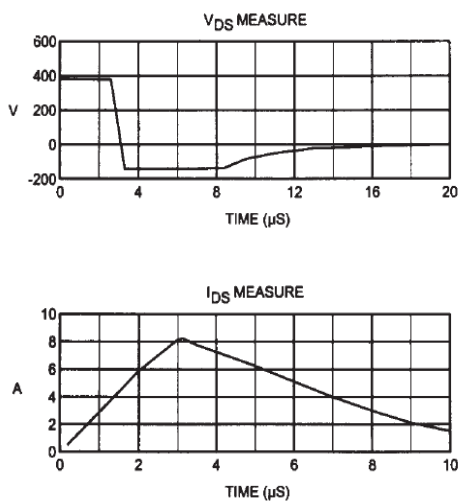
**Fig 4.** Typical Response of Drain to Source Breakdown Vs. Total Dose Exposure



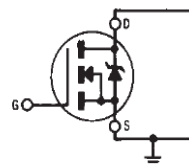
**Fig 5.** Typical Zero Gate Voltage Drain Current Vs. Total Dose Exposure



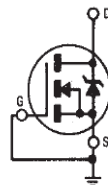
**Fig 6.** Typical On-State Resistance Vs. Neutron Fluence Level



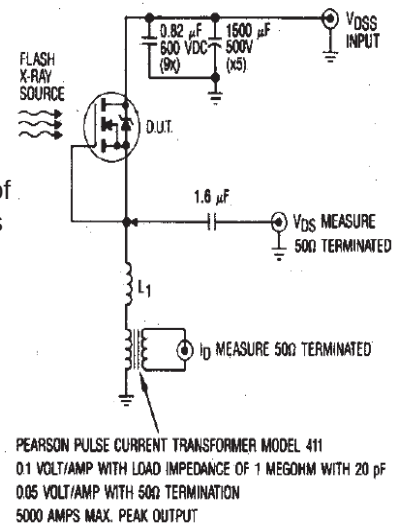
**Fig 7.** Typical Transient Response of Rad Hard HEXFET During  $1 \times 10^{12}$  Rad (Si)/Sec Exposure



**Fig 8a.** Gate Stress of  $V_{GSS}$  Equals 12 Volts During Radiation

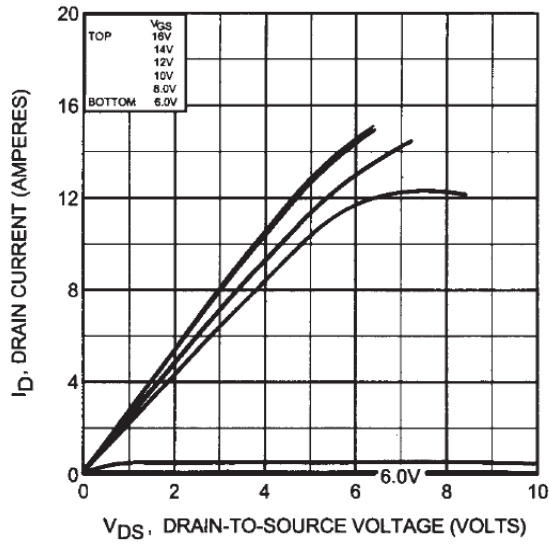


**Fig 8b.**  $V_{DSS}$  Stress Equals 80% of  $B_{VDSS}$  During Radiation

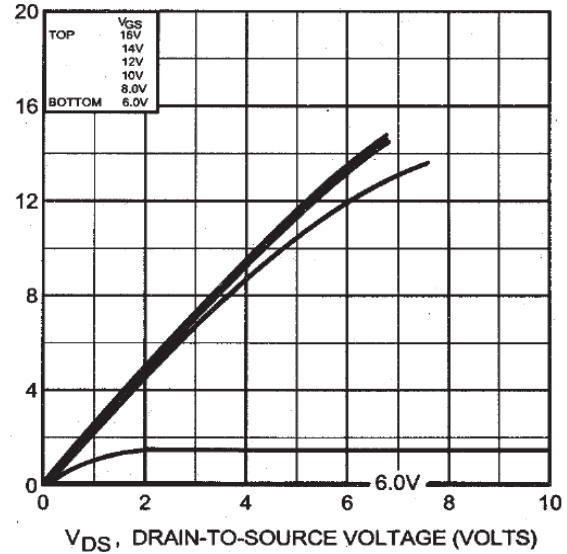


**Fig 9.** High Dose Rate (Gamma Dot) Test Circuit

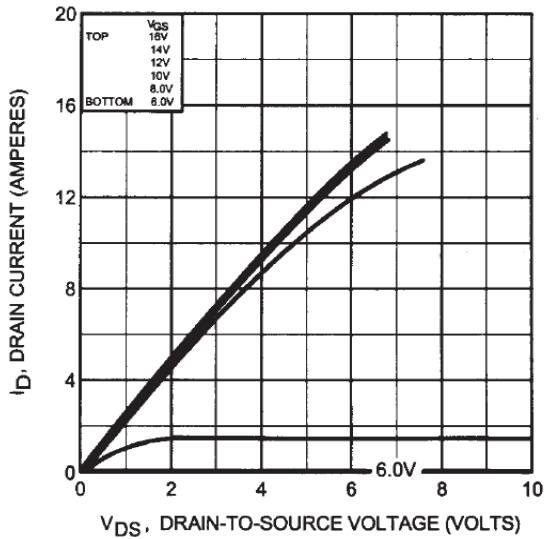
Note: Bias Conditions during radiation:  $V_{GS} = 12\text{ Vdc}$ ,  $V_{DS} = 0\text{ Vdc}$



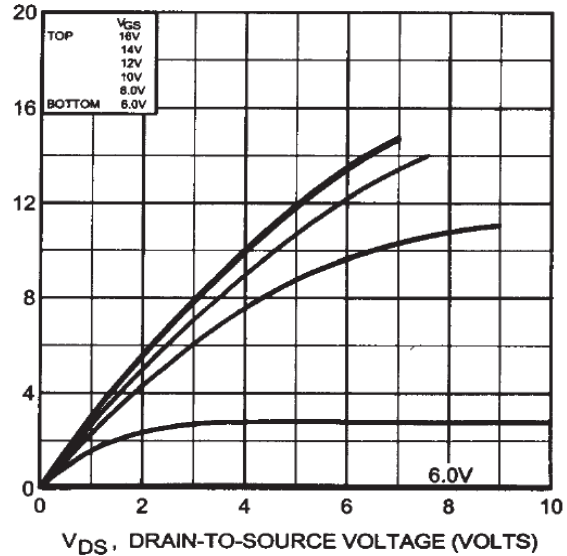
**Fig 10.** Typical Output Characteristics  
Pre-Irradiation



**Fig 11.** Typical Output Characteristics  
Post-Irradiation 100K Rads (Si)



**Fig 12.** Typical Output Characteristics  
Post-Irradiation 300K Rads (Si)

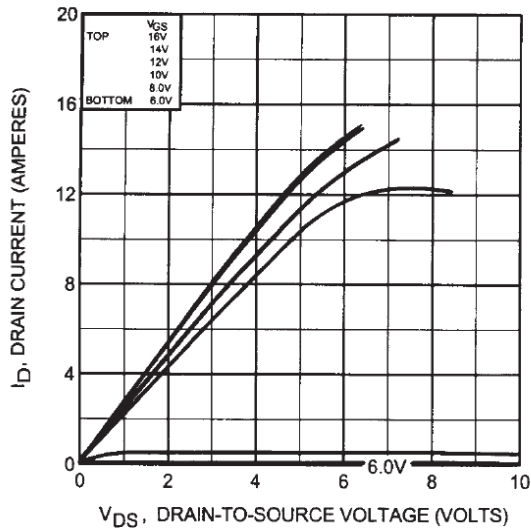


**Fig 13.** Typical Output Characteristics  
Post-Irradiation 1 Mega Rads (Si)

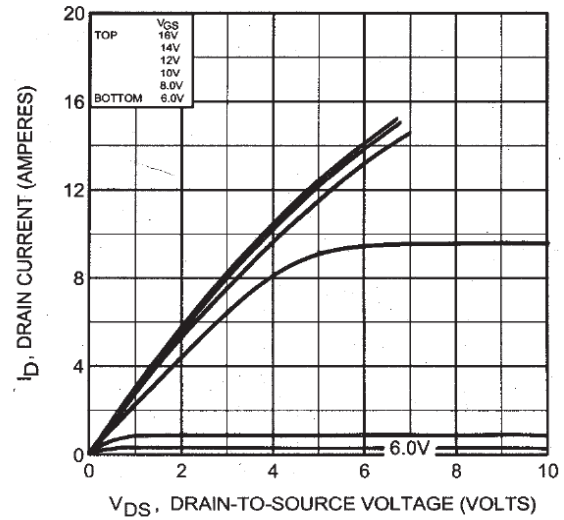
## Radiation Characteristics

IRHN7450, JANSR2N7270U

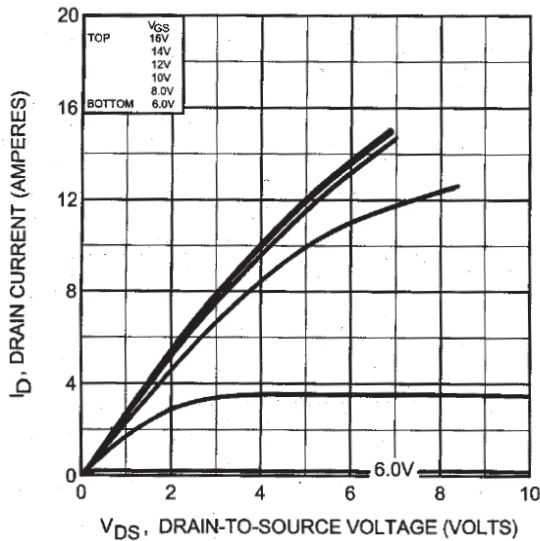
Note: Bias Conditions during radiation:  $V_{GS} = 0$  Vdc,  $V_{DS} = 400$  Vdc



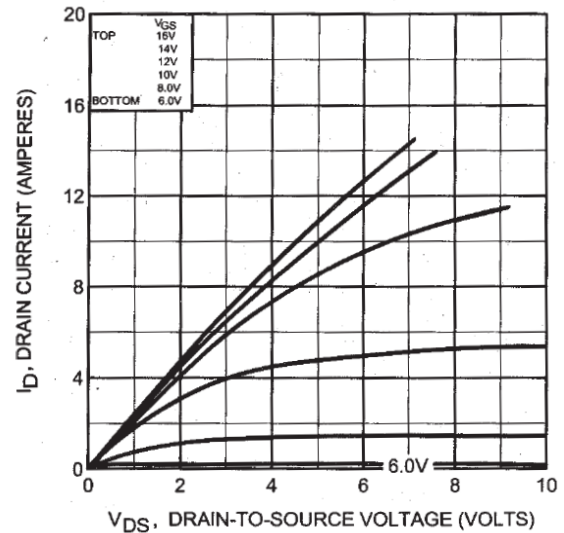
**Fig 14.** Typical Output Characteristics  
Pre-Irradiation



**Fig 15.** Typical Output Characteristics  
Post-Irradiation 100K Rads (Si)



**Fig 16.** Typical Output Characteristics  
Post-Irradiation 300K Rads (Si)



**Fig 17.** Typical Output Characteristics  
Post-Irradiation 1 Mega Rads (Si)

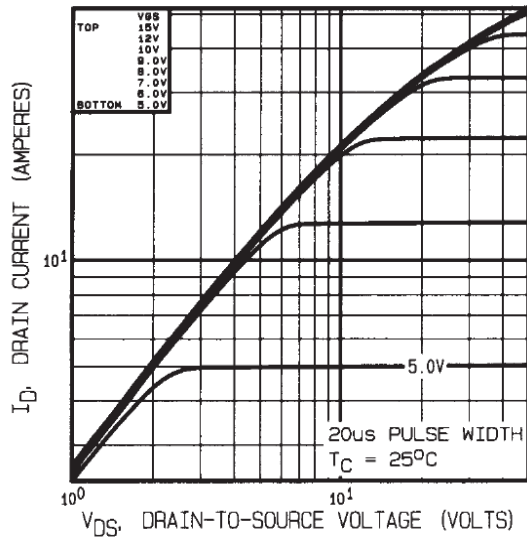


Fig 18. Typical Output Characteristics

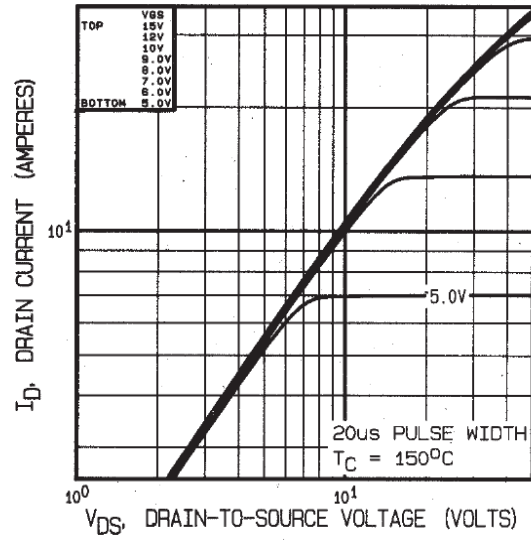


Fig 19. Typical Output Characteristics

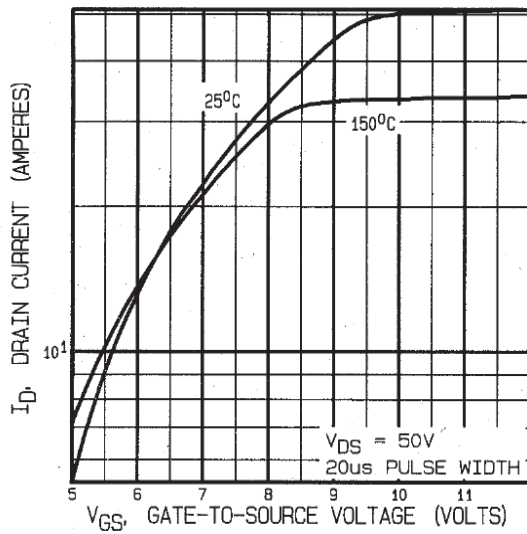


Fig 20. Typical Transfer Characteristics

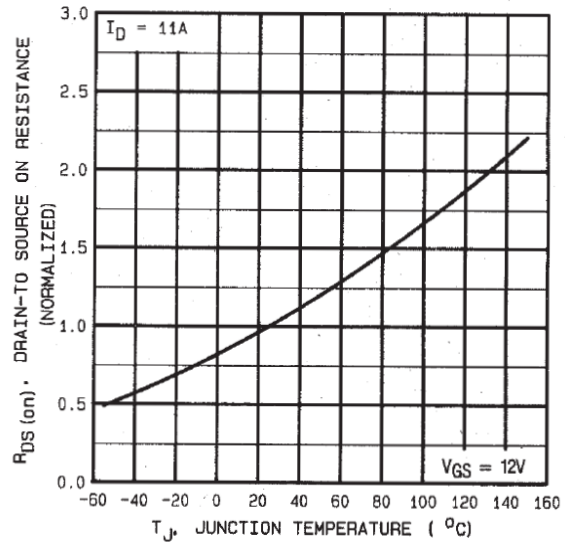
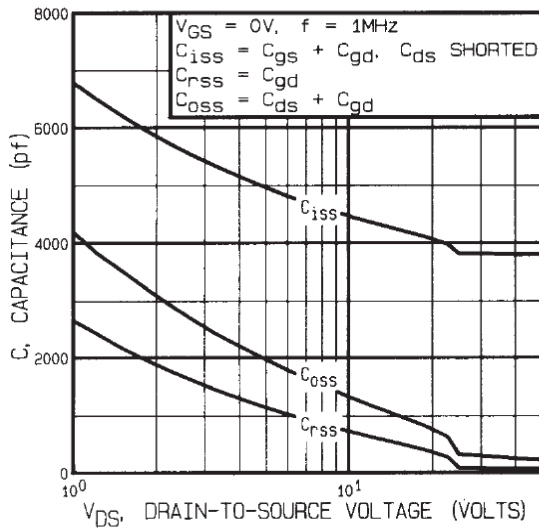


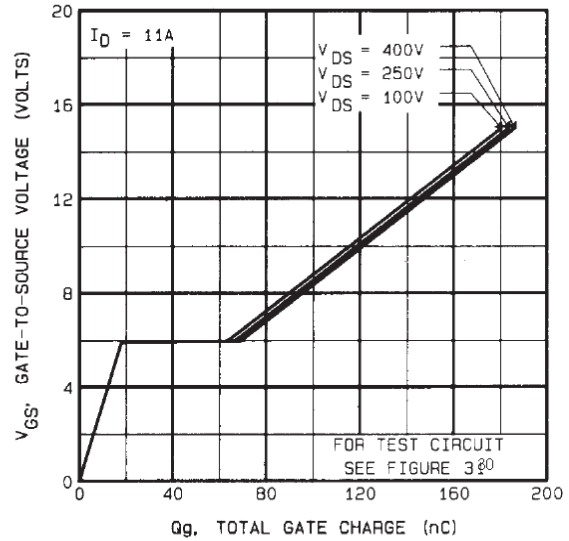
Fig 21. Normalized On-Resistance Vs. Temperature

## Pre-Irradiation

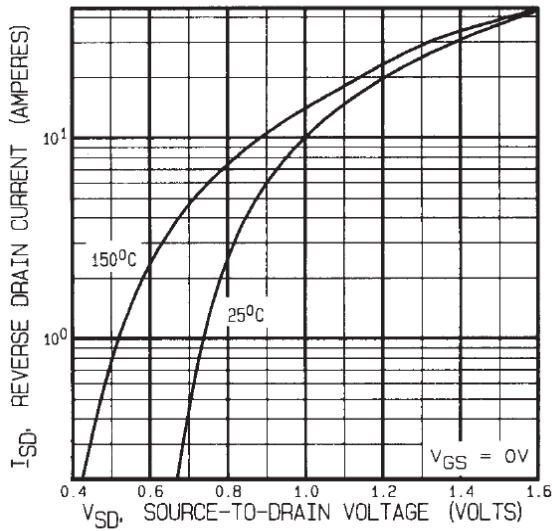
## IRHN7450, JANSR2N7270U



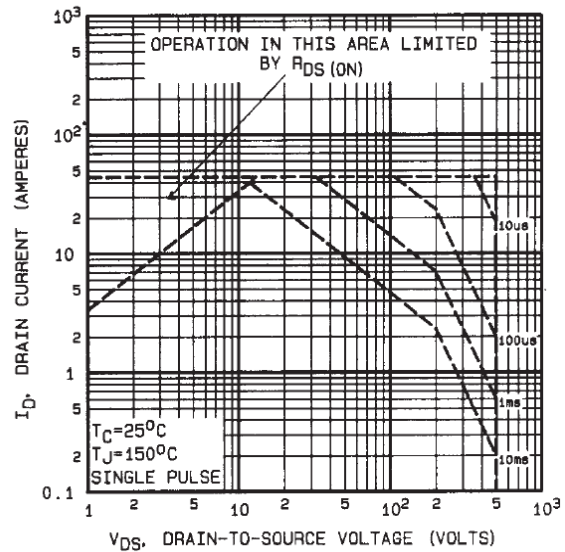
**Fig 22.** Typical Capacitance Vs. Drain-to-Source Voltage



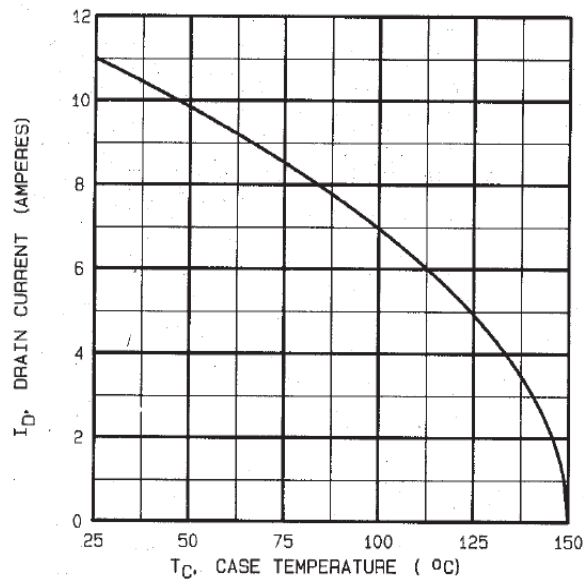
**Fig 23.** Typical Gate Charge Vs. Gate-to-Source Voltage



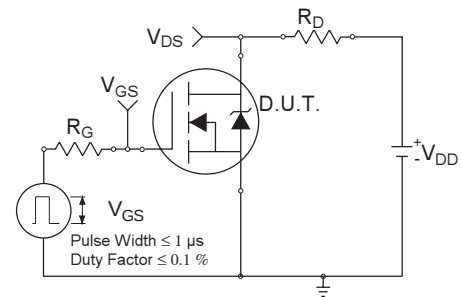
**Fig 24.** Typical Source-Drain Diode Forward Voltage



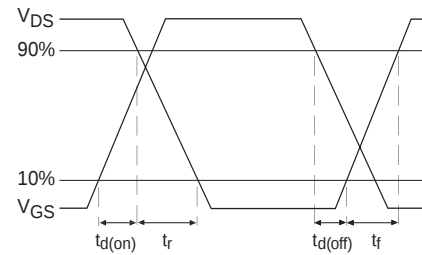
**Fig 25.** Maximum Safe Operating Area



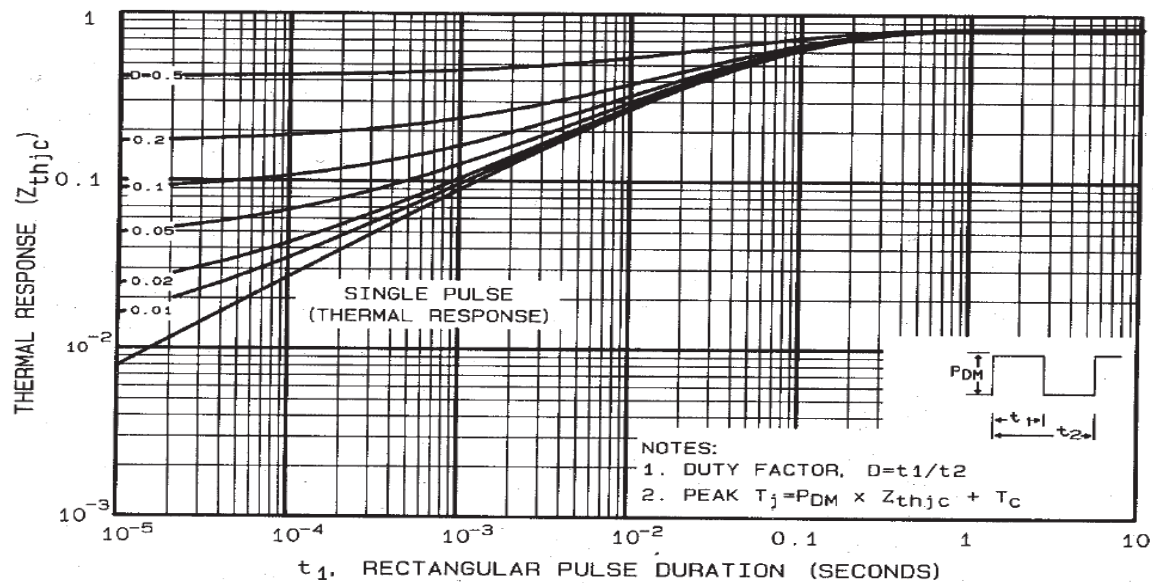
**Fig 26.** Maximum Drain Current Vs. Case Temperature



**Fig 27a.** Switching Time Test Circuit



**Fig 27b.** Switching Time Waveforms



**Fig 28.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

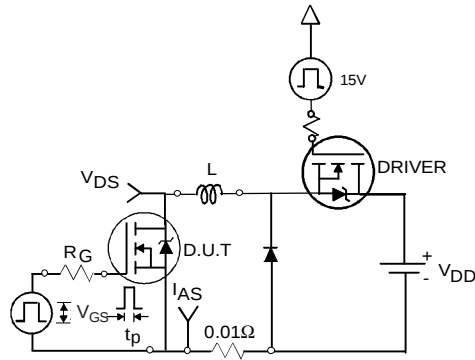


Fig 29a. Unclamped Inductive Test Circuit

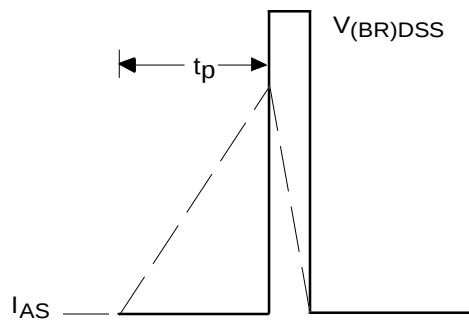


Fig 29b. Unclamped Inductive Waveforms

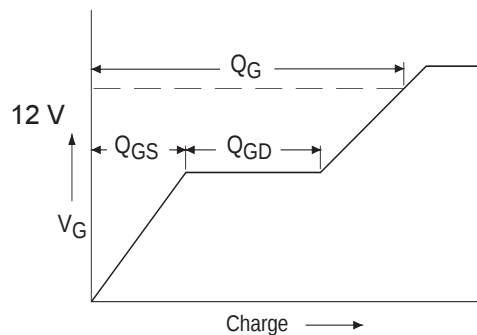


Fig 30a. Basic Gate Charge Waveform

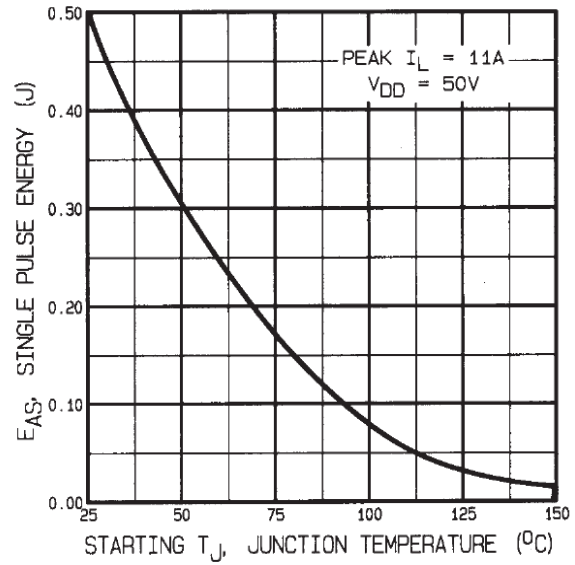


Fig 29c. Maximum Avalanche Energy Vs. Drain Current

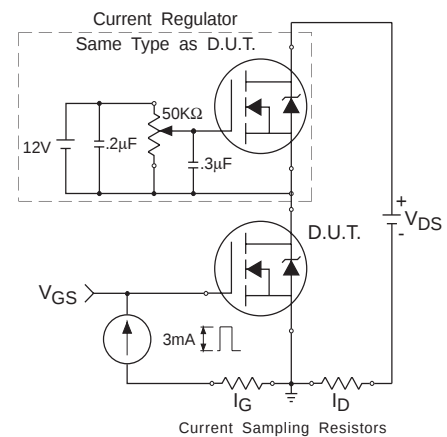
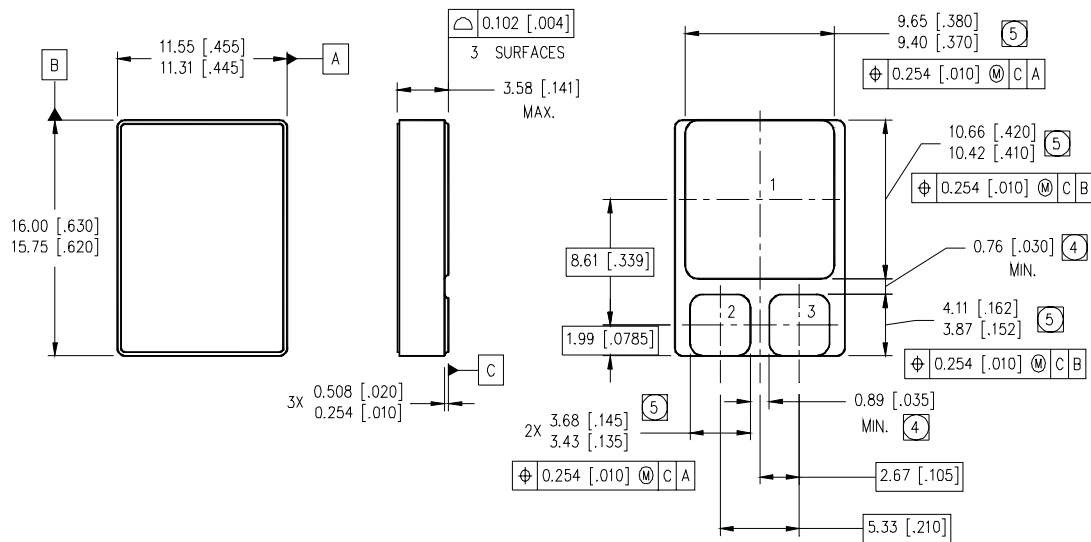


Fig 30b. Gate Charge Test Circuit

**Foot Notes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L \geq 7.4mH$   
Peak  $I_L = 11A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 11A$ ,  $di/dt \leq 140A/\mu s$ ,  
 $V_{DD} \leq 500V$ ,  $T_J \leq 150^\circ C$
- ④ Pulse width  $\leq 300 \mu s$ ; Duty Cycle  $\leq 2\%$
- ⑤ **Total Dose Irradiation with  $V_{GS}$  Bias.**  
12 volt  $V_{GS}$  applied and  $V_{DS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.
- ⑥ **Total Dose Irradiation with  $V_{DS}$  Bias.**  
400 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Case Outline and Dimensions — SMD-1****NOTES:**

- 1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
- 2. CONTROLLING DIMENSION: INCH.
- 3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- ④ DIMENSION INCLUDES METALLIZATION FLASH.
- ⑤ DIMENSION DOES NOT INCLUDE METALLIZATION FLASH.

**PAD ASSIGNMENTS**

- 1 = DRAIN
- 2 = GATE
- 3 = SOURCE

International  
**IOR** Rectifier

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Data and specifications subject to change without notice. 05/2006