

# International IR Rectifier

## RADIATION HARDENED POWER MOSFET SURFACE-MOUNT (SMD-2)

PD - 94299A

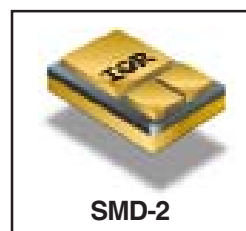
### IRHNA67160

#### 100V, N-CHANNEL

**R<sub>6</sub>** TECHNOLOGY

#### Product Summary

| Part Number | Radiation Level | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-------------|-----------------|---------------------|----------------|
| IRHNA67160  | 100K Rads (Si)  | 0.01Ω               | 56A*           |
| IRHNA63160  | 300K Rads (Si)  | 0.01Ω               | 56A*           |



International Rectifier's R6™ technology provides superior power MOSFETs for space applications. These devices have improved immunity to Single Event Effect (SEE) and have been characterized for useful performance with Linear Energy Transfer (LET) up to 90MeV/(mg/cm<sup>2</sup>). Their combination of very low R<sub>DS(on)</sub> and faster switching times reduces power loss and increases power density in today's high speed switching applications such as DC-DC converters and motor controllers. These devices retain all of the well established advantages of MOSFETs such as voltage control, ease of paralleling and temperature stability of electrical parameters.

#### Features:

- Low R<sub>DS(on)</sub>
- Fast Switching
- Single Event Effect (SEE) Hardened
- 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 |
|--|---------------------------------|---------------|-------|
| I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 25°C  | Continuous Drain Current        | 56*           | A     |
| I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 100°C | Continuous Drain Current        | 56*           |       |
| I <sub>DM</sub>  | Pulsed Drain Current ①          | 224           |       |
| P <sub>D</sub> @ T <sub>C</sub> = 25°C                         | Max. Power Dissipation          | 250           | W     |
|  | Linear Derating Factor          | 2.0           | W/°C  |
| V <sub>GS</sub>  | Gate-to-Source Voltage          | ±20           | V     |
| EAS  | Single Pulse Avalanche Energy ② | 462           | mJ    |
| I <sub>AR</sub>  | Avalanche Current ①             | 56            | A     |
| EAR  | Repetitive Avalanche Energy ①   | 25            | mJ    |
| dv/dt  | Peak Diode Recovery dv/dt ③     | 5.0           | V/ns  |
| T <sub>J</sub>   | Operating Junction              | -55 to 150    | °C    |
| T <sub>STG</sub>   | Storage Temperature Range       |               |       |
|  | Pckg. Mounting Surface Temp.    | 300 (for 5s)  |       |
|  | Weight                          | 3.3 (Typical) | g     |

\* Current is limited by package  
For footnotes refer to the last page

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## IRHNA67160

## Pre-Irradiation

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            | 100 | —    | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA  |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | Temperature Coefficient of Breakdown Voltage | —   | 0.11 | —    | V/°C  | Reference to 25°C, I <sub>D</sub> = 1.0mA   |
| R <sub>DS(on)</sub>                 | Static Drain-to-Source On-State Resistance   | —   | —    | 0.01 | Ω     | V <sub>GS</sub> = 12V, I <sub>D</sub> = 56A ④   |
| 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                     | 60  | —    | —    | S (Ω) | V <sub>DS</sub> = 25V, I <sub>DS</sub> = 56A ④  |
| I <sub>DSS</sub>                    | Zero Gate Voltage Drain Current              | —   | —    | 10   | μA    | V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V   |
|                                     |  | —   | —    | 25   |       | V <sub>DS</sub> = 80V,<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 |       | V <sub>GS</sub> = -20V  |
| Q <sub>g</sub>                      | Total Gate Charge                            | —   | —    | 220  | nC    | V <sub>GS</sub> = 12V, I <sub>D</sub> = 56A<br>V <sub>DS</sub> = 50V                          |
| Q <sub>gs</sub>                     | Gate-to-Source Charge                        | —   | —    | 80   |       |   |
| Q <sub>gd</sub>                     | Gate-to-Drain ('Miller') Charge              | —   | —    | 80   |       |   |
| t <sub>d(on)</sub>                  | Turn-On Delay Time                           | —   | —    | 35   | ns    | V <sub>DD</sub> = 50V, I <sub>D</sub> = 56A,<br>V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω |
| t <sub>r</sub>                      | Rise Time                                    | —   | —    | 75   |       |   |
| t <sub>d(off)</sub>                 | Turn-Off Delay Time                          | —   | —    | 75   |       |   |
| t <sub>f</sub>                      | Fall Time                                    | —   | —    | 20   |       |   |
| L <sub>S</sub> + L <sub>D</sub>     | Total Inductance                             | —   | 2.8  | —    | nH    | Measured from the center of drain pad to center of source pad                                 |
| C <sub>iss</sub>                    | Input Capacitance                            | —   | 8690 | —    | pF    | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V<br>f = 1.0MHz                                     |
| C <sub>oss</sub>                    | Output Capacitance                           | —   | 1600 | —    |       |   |
| C <sub>rss</sub>                    | Reverse Transfer Capacitance                 | —   | 20   | —    |       |   |
| R <sub>g</sub>                      | Internal Gate Resistance                     | —   | 0.45 | —    |       |   |

## Source-Drain Diode Ratings and Characteristics

|                 | Parameter                              | Min  | Typ | Max | Units | Test Conditions   |
|-----------------|--|--|-----|-----|-------|---|
| I <sub>S</sub>  | Continuous Source Current (Body Diode) | —  | —   | 56* | A     | T <sub>j</sub> = 25°C, I <sub>S</sub> = 56A, V <sub>GS</sub> = 0V ④                     |
| I <sub>SM</sub> | Pulse Source Current (Body Diode) ①    | —  | —   | 224 |       |   |
| V <sub>SD</sub> | Diode Forward Voltage                  | —  | —   | 1.2 | V     | T <sub>j</sub> = 25°C, I <sub>F</sub> = 56A, di/dt ≤ 100A/μs<br>V <sub>DD</sub> ≤ 25V ④ |
| t <sub>rr</sub> | Reverse Recovery Time                  | —  | —   | 500 | ns    |   |
| Q <sub>RR</sub> | Reverse Recovery Charge                | —  | —   | 5.5 | 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> . |     |     |       |   |

\* Current is limited by package

## Thermal Resistance

|                   | Parameter        | Min | Typ | Max | Units | Test Conditions |
|-------------------|------------------|-----|-----|-----|-------|-----------------|
| R <sub>thJC</sub> | Junction-to-Case | —   | —   | 0.5 | °C/W  |                 |

Note: Corresponding Spice and Saber models are available on International Rectifier Web site.

For footnotes refer to the last page

## Radiation Characteristics

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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 @ T<sub>j</sub> = 25°C, Post Total Dose Irradiation ⑤⑥**

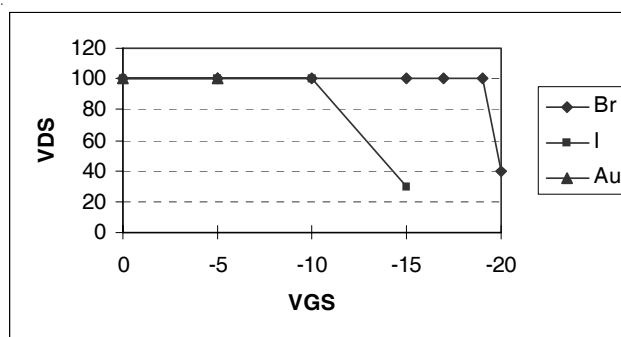
|                     | Parameter   | Up to 300K Rads (Si) |       | Units | Test Conditions ③  |
|---------------------|---|----------------------|-------|-------|--|
|                     |   | Min                  | Max   |       |  |
| BV <sub>DSS</sub>   | Drain-to-Source Breakdown Voltage                       | 100                  | —     | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA               |
| V <sub>GS(th)</sub> | Gate Threshold Voltage                                  | 2.0                  | 4.0   |       | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0mA |
| 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  |       | V <sub>GS</sub> = -20V                                     |
| I <sub>DSS</sub>    | Zero Gate Voltage Drain Current                         | —                    | 10    | μA    | V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V                |
| R <sub>DS(on)</sub> | Static Drain-to-Source ④<br>On-State Resistance (TO-3)  | —                    | 0.011 | Ω     | V <sub>GS</sub> = 12V, I <sub>D</sub> = 56A                |
| R <sub>DS(on)</sub> | Static Drain-to-Source ④<br>On-State Resistance (SMD-2) | —                    | 0.010 | Ω     | V <sub>GS</sub> = 12V, I <sub>D</sub> = 56A                |
| V <sub>SD</sub>     | Diode Forward Voltage ④                                 | —                    | 1.2   | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 56A                 |

Part numbers IRHNA67160 and IRHNA63160

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) | VDS (V)       |                |                 |                 |                 |                 |                 |
|-----|------------------------------------|-----------------|---------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|     |                                    |                 |               | @ VGS =<br>0V | @ VGS =<br>-5V | @ VGS =<br>-10V | @ VGS =<br>-15V | @ VGS =<br>-17V | @ VGS =<br>-19V | @ VGS =<br>-20V |
| Br  | 36.7                               | 309             | 39.5          | 100           | 100            | 100             | 100             | 100             | 100             | 40              |
| I   | 59.8                               | 341             | 32.5          | 100           | 100            | 100             | 30              | -               | -               | -               |
| Au  | 82.3                               | 350             | 28.4          | 100           | 100            | -               | -               | -               | -               | -               |



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

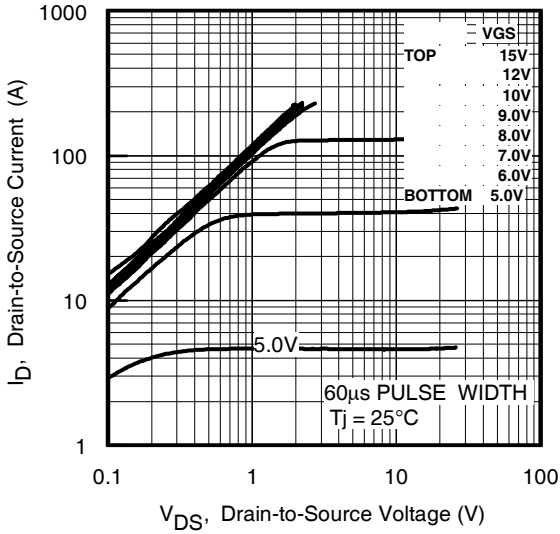
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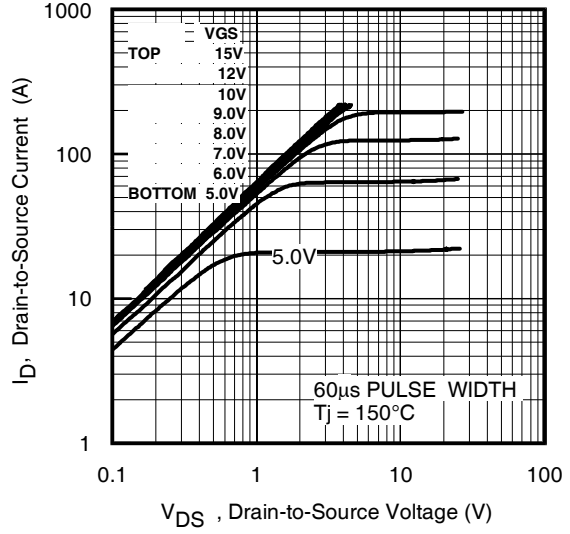
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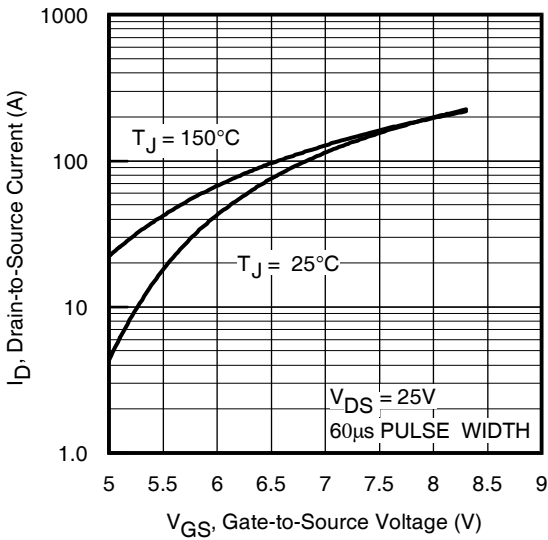
**Pre-Irradiation**



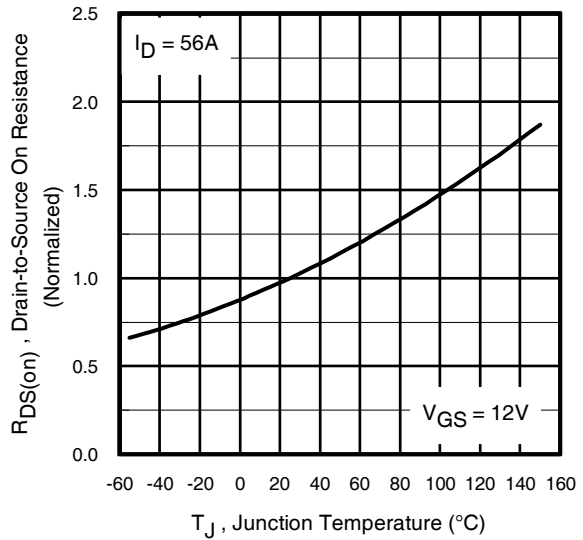
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics



**Fig 3.** Typical Transfer Characteristics



**Fig 4.** Normalized On-Resistance Vs. Temperature

Pre-Irradiation

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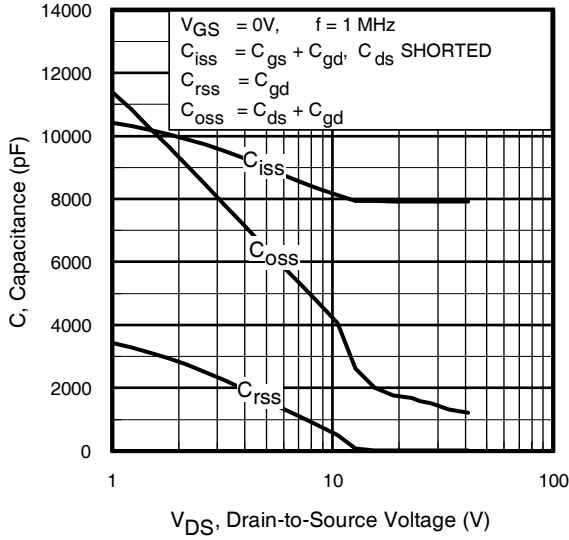


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

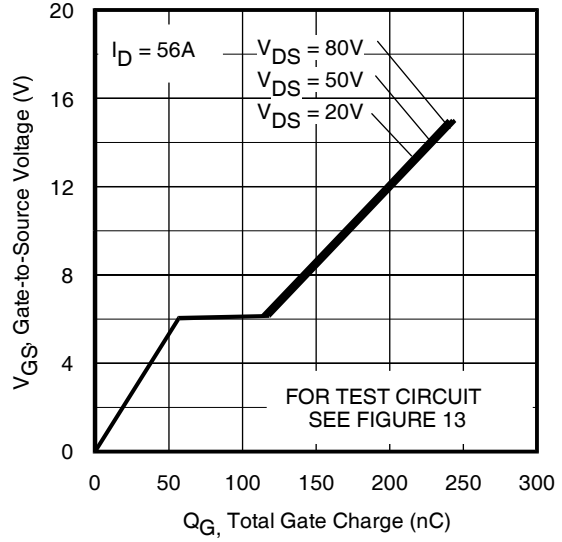


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

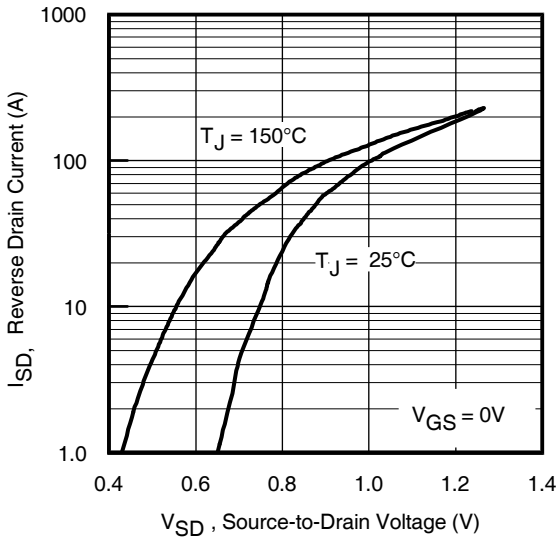


Fig 7. Typical Source-Drain Diode Forward Voltage

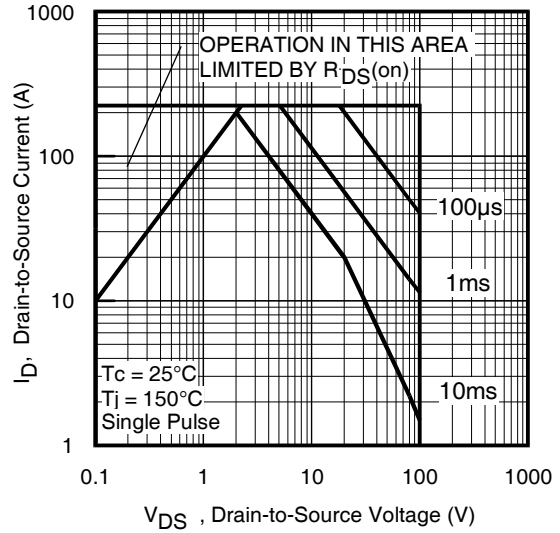


Fig 8. Maximum Safe Operating Area

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Pre-Irradiation

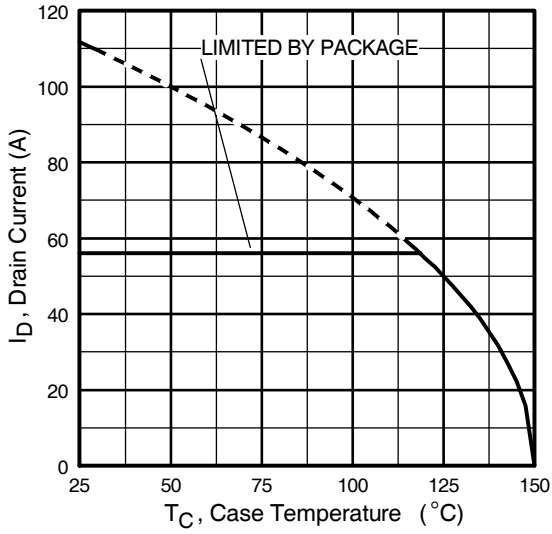


Fig 9. Maximum Drain Current Vs. Case Temperature

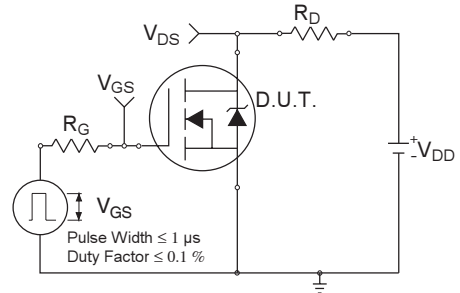


Fig 10a. Switching Time Test Circuit

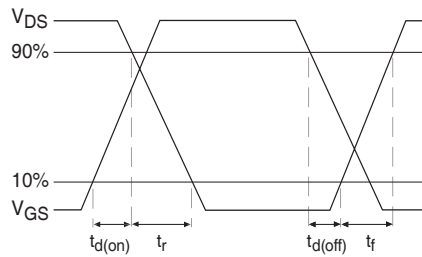


Fig 10b. Switching Time Waveforms

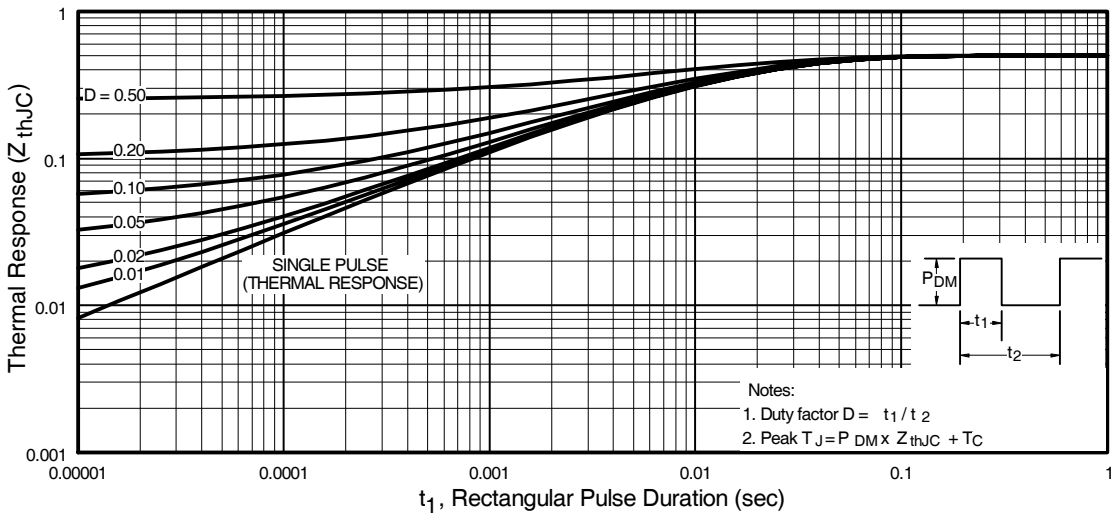


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

Pre-Irradiation

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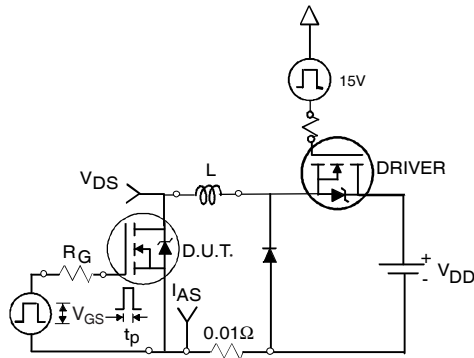


Fig 12a. Unclamped Inductive Test Circuit

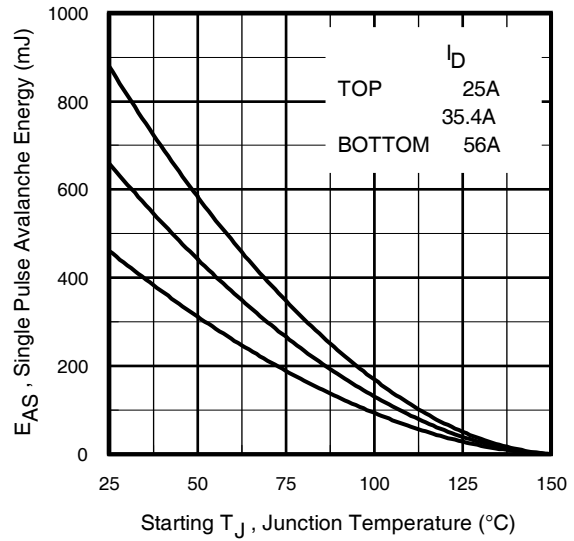


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

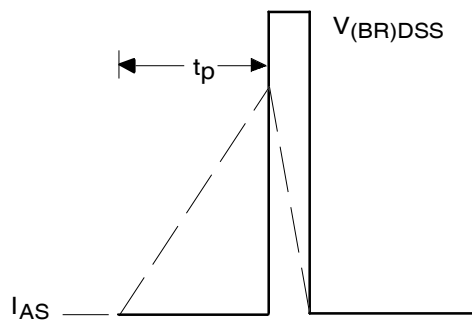


Fig 12b. Unclamped Inductive Waveforms

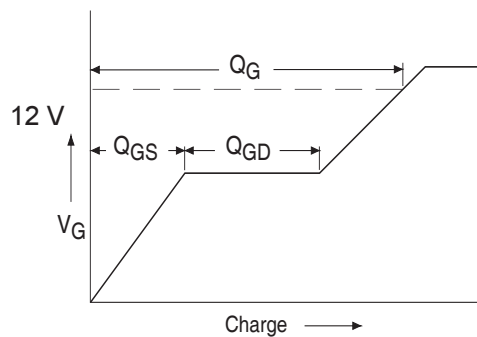


Fig 13a. Basic Gate Charge Waveform

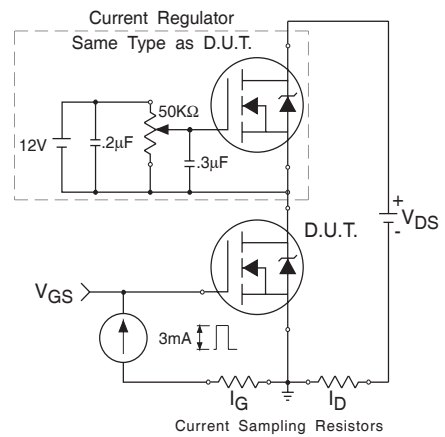


Fig 13b. Gate Charge Test Circuit

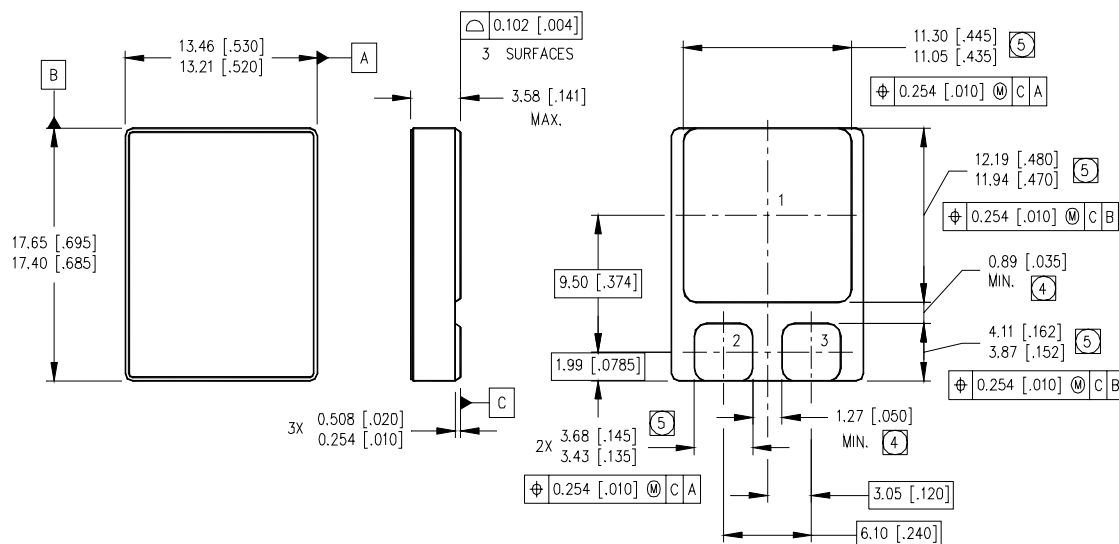
## IRHNA67160

## Pre-Irradiation

## Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L = 0.29mH$   
Peak  $I_L = 56A$ ,  $V_{GS} = 12V$
- ③  $ISD \leq 56A$ ,  $di/dt \leq 640A/\mu s$ ,  
 $V_{DD} \leq 100V$ ,  $T_J \leq 150^\circ C$
- 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.**  
80 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

## Case Outline and Dimensions — SMD-2



## NOTES:

- DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
- CONTROLLING DIMENSION: INCH.
- 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

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IR Rectifier

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