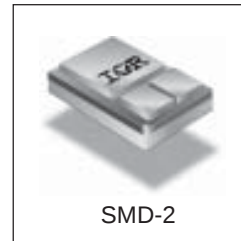


## RAD-HARD SYNCHRONOUS RECTIFIER SURFACE MOUNT (SMD-2)

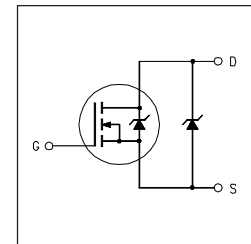
## IRHSNA57Z60 30V, N-CHANNEL

### Product Summary

| Part Number | Radiation Level | RDS(on) | QG    |
|-------------|-----------------|---------|-------|
| IRHSNA57Z60 | 100K Rads (Si)  | 3.5mΩ   | 200nC |
| IRHSNA53Z60 | 300K Rads (Si)  | 3.5mΩ   | 200nC |
| IRHSNA54Z60 | 600K Rads (Si)  | 3.5mΩ   | 200nC |
| IRHSNA58Z60 | 1000K Rads (Si) | 4.0mΩ   | 200nC |



SMD-2



### Description:

The SynchFet family of Co-Pack RAD-Hard MOSFETs and Schottky diodes offers the designer an innovative, board space saving solution for switching regulator and power management applications. RAD-Hard MOSFETs utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. Combining this technology with International Rectifier's low forward drop Schottky rectifiers results in an extremely efficient device suitable for use in a wide variety of Military and Space applications.

### Features:

- Co-Pack N-channel RAD-Hard MOSFET and Schottky Diode
- Ideal for Synchronous Rectifiers in DC-DC Converters up to 75A Output
- Low Conduction Losses
- Low Switching Losses
- Low Vf Schottky Rectifier
- Refer to IRHSLNA57Z60 for Lower Inductance

### Absolute Maximum Ratings

### Pre-Irradiation

|                            | Parameter                                      |               | Units |
|----------------------------|------------------------------------------------|---------------|-------|
| ID @ VGS = 12V, TC = 25°C  | Continuous Drain or Source Current             | 75*           | A     |
| ID @ VGS = 12V, TC = 100°C | Continuous Drain or Source Current             | 75*           |       |
| IDM                        | Pulsed Drain Current ①                         | 300           |       |
| PD @ TC = 25°C             | Max. Power Dissipation                         | 250           | W     |
|                            | Linear Derating Factor                         | 2.0           | W/°C  |
| VGS                        | Gate-to-Source Voltage                         | ±20           | V     |
| EAS                        | Single Pulse Avalanche Energy ④                | 500           | mJ    |
| IAR                        | Avalanche Current ①                            | 75            | A     |
| EAR                        | Repetitive Avalanche Energy ①                  | 25            | mJ    |
| IF (AV) @ TC = 25°C        | Schottky and Body Diode Avg. Forward Current ③ | 75*           | A     |
| IF (AV) @ TC = 100°C       | Schottky and Body Diode Avg. Forward Current ③ | 75*           |       |
| TJ, TSTG                   | Operating and Storage Temperature Range        | -55 to 150    | °C    |
|                            | Pckg. Mounting Surface Temp.                   | 300 (for 5s)  |       |
|                            | Weight                                         | 3.3 (Typical) |       |

\* Current is limited by package

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          | 30  | —    | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA                                               |
| R <sub>DS(on)</sub>             | Static Drain-to-Source On-State Resistance | —   | —    | 3.5  | mΩ    | V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A②                                               |
| 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                   | 45  | —    | —    | S (Ω) | V <sub>DS</sub> ≥ 15V, I <sub>DS</sub> = 45A②                                              |
| I <sub>DSS</sub>                | Zero Gate Voltage Drain Current            | —   | —    | 50   | μA    | V <sub>DS</sub> = 24V, V <sub>GS</sub> = 0V                                                |
|                                 |                                            | —   | —    | 50   | mA    | V <sub>DS</sub> = 24V, 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                          | —   | —    | 200  | nC    | V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A, V <sub>DS</sub> = 15V                         |
| Q <sub>gs</sub>                 | Gate-to-Source Charge                      | —   | —    | 55   |       |                                                                                            |
| Q <sub>gd</sub>                 | Gate-to-Drain ("Miller") Charge            | —   | —    | 40   |       |                                                                                            |
| t <sub>d(on)</sub>              | Turn-On Delay Time                         | —   | —    | 35   | ns    | V <sub>DD</sub> = 15V, I <sub>D</sub> = 45A, V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω |
| t <sub>r</sub>                  | Rise Time                                  | —   | —    | 160  |       |                                                                                            |
| t <sub>d(off)</sub>             | Turn-Off Delay Time                        | —   | —    | 78   |       |                                                                                            |
| t <sub>f</sub>                  | Fall Time                                  | —   | —    | 26   |       |                                                                                            |
| L <sub>S</sub> + L <sub>D</sub> | Total Inductance                           | —   | 7.03 | —    | nH    | Measured from center of drain pad to center of source pad                                  |

**Schottky Diode & Body Diode Ratings and Characteristics**

|                                 | Parameter               | Min                                                                                                                | Typ  | Max  | Units | Test Conditions                                                               |
|---------------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------|------|------|-------|-------------------------------------------------------------------------------|
| V <sub>SD</sub>                 | Diode Forward Voltage   | —                                                                                                                  | —    | 1.15 | V     | T <sub>J</sub> = -55°C, I <sub>D</sub> = 45A, V <sub>GS</sub> = 0V②           |
|                                 |                         | —                                                                                                                  | —    | 1.05 |       | T <sub>J</sub> = 25°C, I <sub>D</sub> = 45A, V <sub>GS</sub> = 0V②            |
|                                 |                         | —                                                                                                                  | —    | 0.95 |       | T <sub>J</sub> = 110°C, I <sub>D</sub> = 45A, V <sub>GS</sub> = 0V②           |
| t <sub>rr</sub>                 | Reverse Recovery Time   | —                                                                                                                  | —    | 175  | nS    | T <sub>J</sub> = 25°C, I <sub>F</sub> = 45A, di/dt ≤ 100A/μs                  |
| Q <sub>RR</sub>                 | Reverse Recovery Charge | —                                                                                                                  | —    | 500  | nC    | V <sub>DS</sub> ≤ 30V                                                         |
| L <sub>S</sub> + L <sub>D</sub> | Total Inductance        | —                                                                                                                  | 8.09 | —    | nH    | Measured from center of drain pad to center of source pad (for Schottky only) |
| 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 (MOSFET)   | —   | —   | 0.5 | °C/W  |                 |
| R <sub>thJC</sub> | Junction-to-Case (Schottky) | —   | —   | 0.7 |       |                 |

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

For footnotes refer to the last page

## Radiation Characteristics

## IRHSNA57Z60

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** ⑤⑥⑦

|                     | Parameter                                               | Up to 600K Rads(Si) <sup>1</sup> |      | 1000K Rads (Si) <sup>2</sup> |      | Units | Test Conditions                                            |
|---------------------|---------------------------------------------------------|----------------------------------|------|------------------------------|------|-------|------------------------------------------------------------|
|                     |                                                         | Min                              | Max  | Min                          | Max  |       |                                                            |
| BV <sub>DSS</sub>   | Drain-to-Source Breakdown Voltage                       | 30                               | —    | 30                           | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA               |
| V <sub>GS(th)</sub> | Gate Threshold Voltage                                  | 2.0                              | 4.0  | 1.5                          | 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  | —                            | 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                         | —                                | 10   | —                            | 25   | μA    | V <sub>DS</sub> = 24V, V <sub>GS</sub> = 0V                |
| R <sub>DS(on)</sub> | Static Drain-to-Source ②<br>On-State Resistance (TO-3)  | —                                | 4.0  | —                            | 5.0  | mΩ    | V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A                |
| R <sub>DS(on)</sub> | Static Drain-to-Source ②<br>On-State Resistance (SMD-2) | —                                | 3.5  | —                            | 4.0  | mΩ    | V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A                |
| V <sub>SD</sub>     | Diode Forward Voltage ②                                 | —                                | 1.3  | —                            | 1.3  | V     | V <sub>GS</sub> = 0V, I <sub>S</sub> = 45A                 |

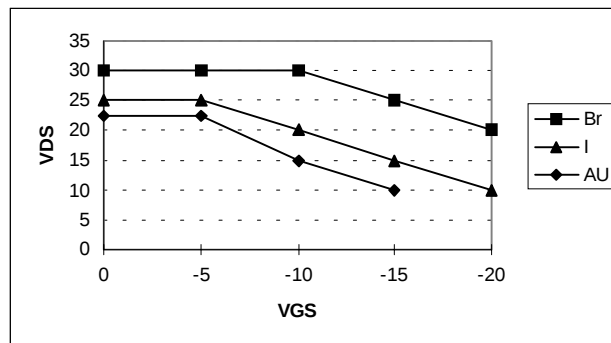
1. Part numbers IRHSNA57Z60, IRHSNA53Z60 and IRHSNA54Z60

2. Part number IRHSNA58Z60

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** ⑦

| 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 |
| Br  | 37.9                             | 255             | 33.4          | 30                   | 30                    | 30                     | 25                     | 20                     |
| I   | 59.4                             | 290             | 28.8          | 25                   | 25                    | 20                     | 15                     | 10                     |
| Au  | 80.3                             | 313             | 26.5          | 22.5                 | 22.5                  | 15                     | 10                     | —                      |



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

For footnotes refer to the last page

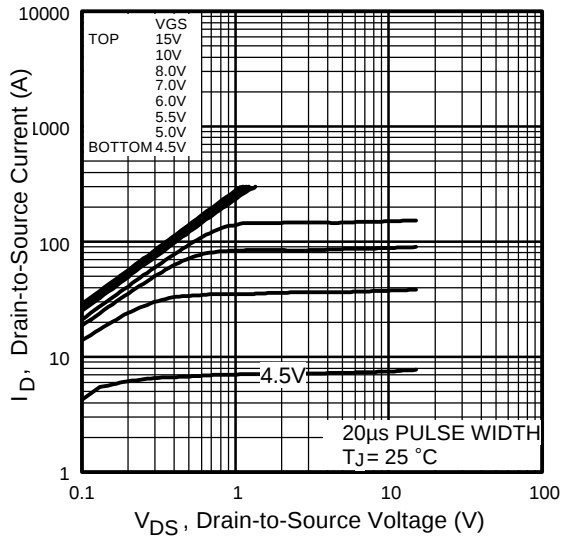


Fig 1. Typical Output Characteristics

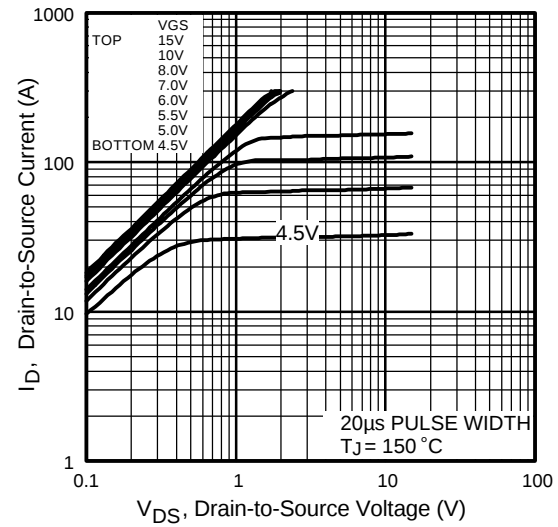


Fig 2. Typical Output Characteristics

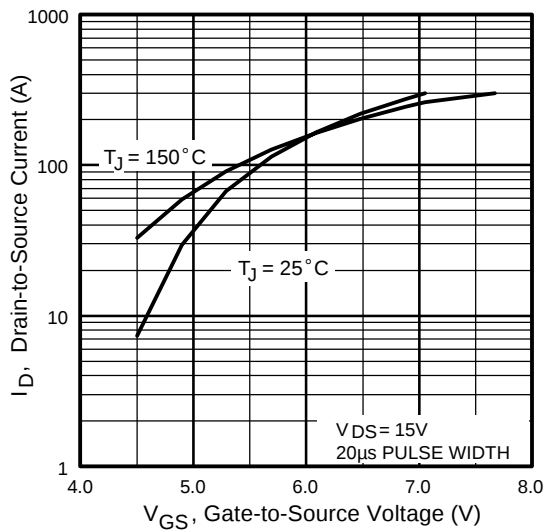


Fig 3. Typical Transfer Characteristics

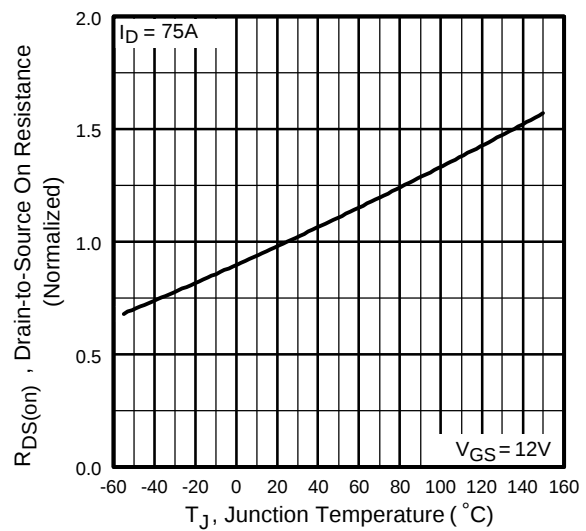


Fig 4. Normalized On-Resistance Vs. Temperature

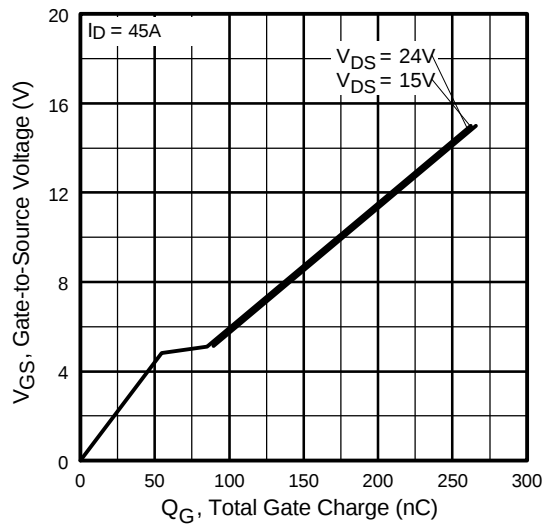


Fig 5. Typical Gate Charge Vs. Gate-to-Source Voltage

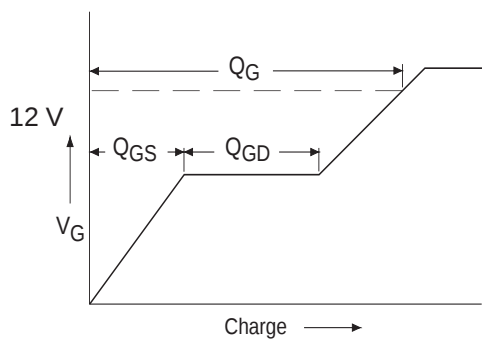


Fig 5a. Basic Gate Charge Waveform

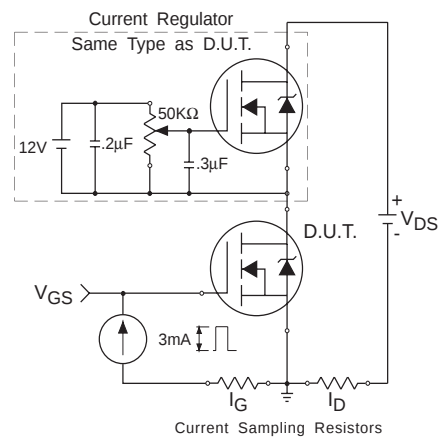
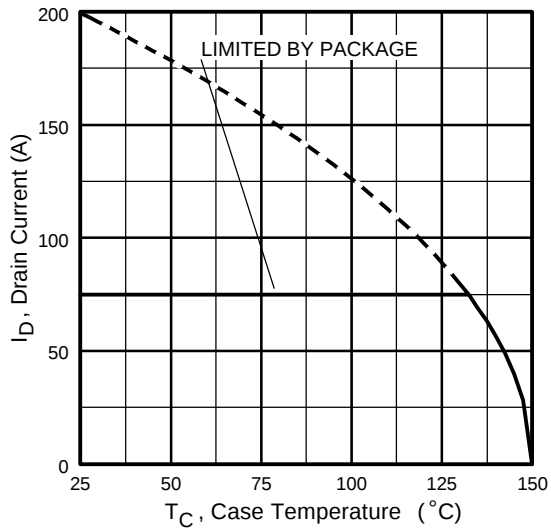
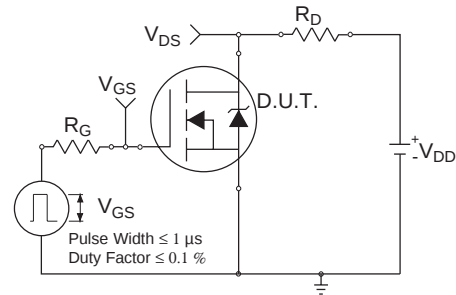


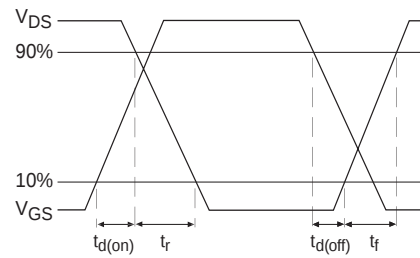
Fig 5b. Gate Charge Test Circuit



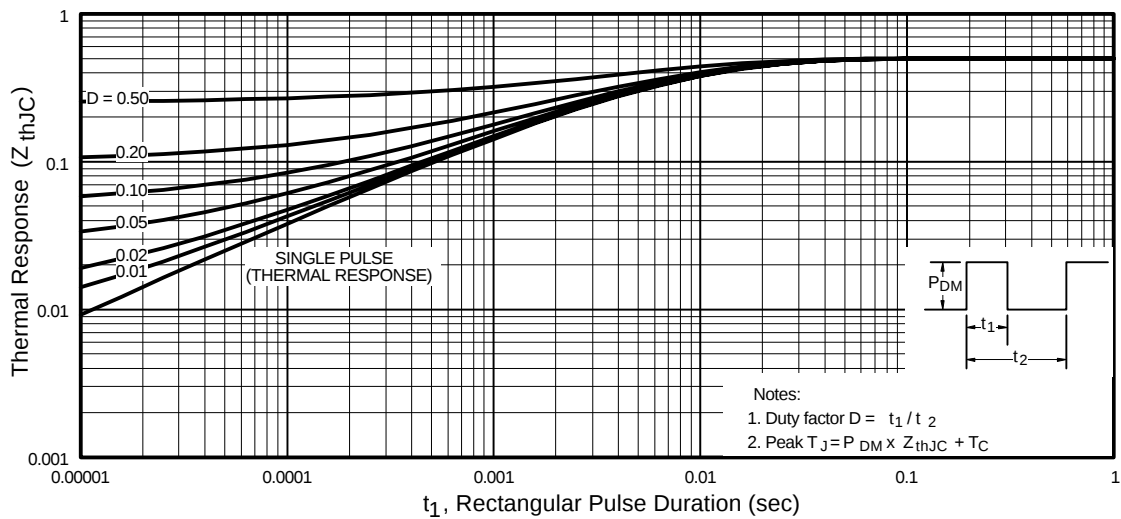
**Fig 6.** Maximum Drain Current Vs. Case Temperature



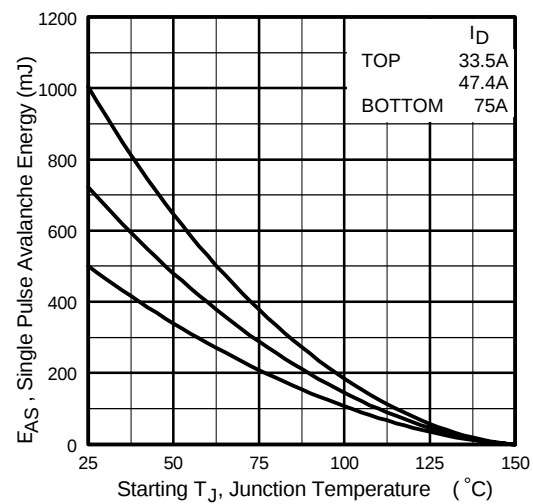
**Fig 7a.** Switching Time Test Circuit



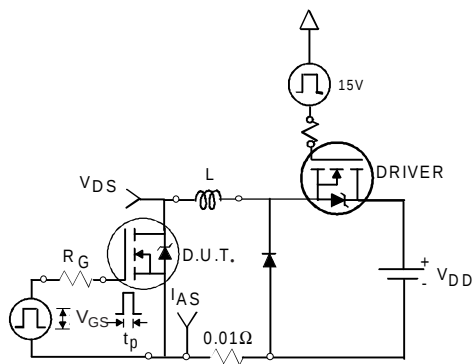
**Fig 7b.** Switching Time Waveforms



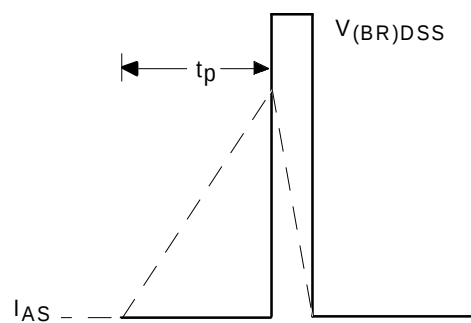
**Fig 8.** Maximum Effective Transient Thermal Impedance, Junction-to-Case, MOSFET



**Fig 9.** Maximum Avalanche Energy Vs. Drain Current



**Fig 9a.** Unclamped Inductive Test Circuit



**Fig 9b.** Unclamped Inductive Waveforms

## MOSFET Body Diode &amp; Schottky Diode Characteristics

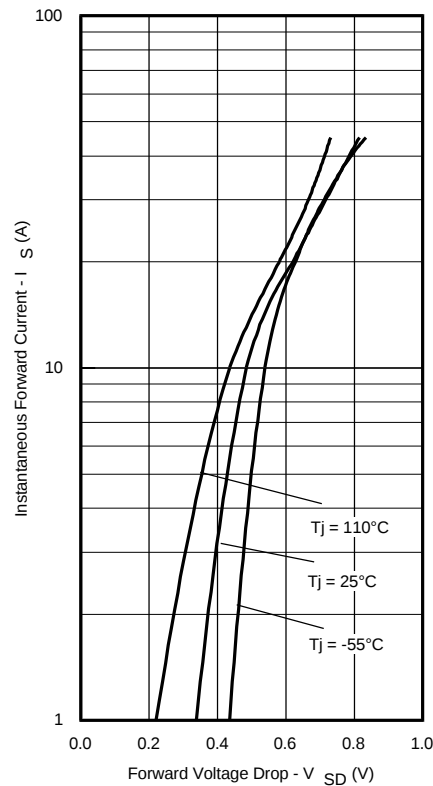


Fig. 10 - Typical Forward Voltage Drop Characteristics

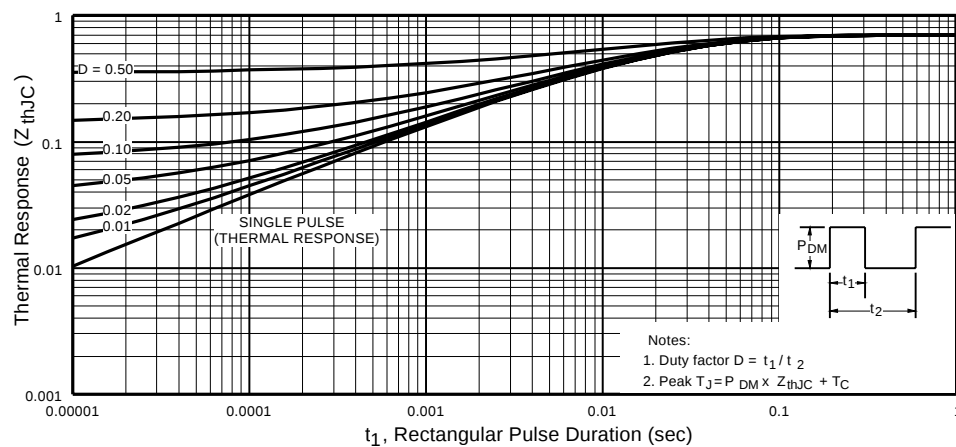


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case, Schottky

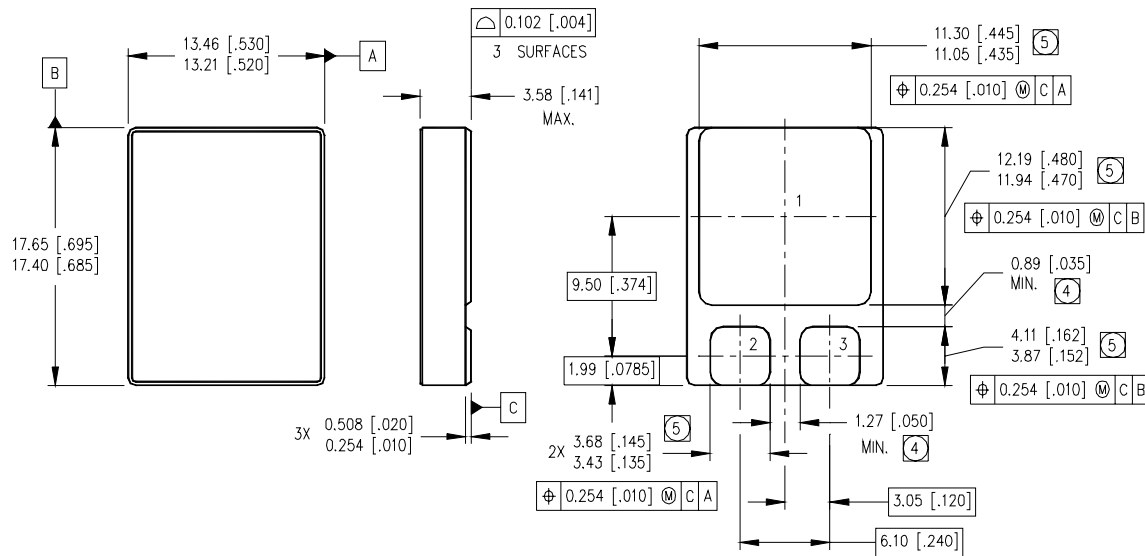
## Pre-Irradiation

IRHSNA57Z60

### Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature
- ② Pulse width  $\leq 300 \mu\text{s}$ ; Duty Cycle  $\leq 2\%$
- ③ 50% Duty Cycle, Rectangular
- ④  $V_{DD} = 25\text{V}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.3 \text{ mH}$   
Peak  $I_L = 75\text{A}$ ,  $V_{GS} = 12\text{V}$
- 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.**  
24 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.
- ⑦ Specified Radiation Characteristics are for Radiation Hardened MOSFET die only.

### Case Outline and Dimensions — SMD-2



#### 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  
**IR** Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
TAC Fax: (310) 252-7903

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