

## REPETITIVE AVALANCHE AND $dv/dt$ RATED HEXFET® TRANSISTOR

## IRHNA7Z60 IRHNA8Z60 N-CHANNEL MEGA RAD HARD

### 30 Volt, 0.009W, RAD HARD HEXFET

International Rectifier's RAD HARD technology HEXFETs demonstrate immunity to SEE failure. Additionally, under **identical** pre- and post-irradiation test conditions, International Rectifier's RAD HARD HEXFETs retain **identical** electrical specifications up to  $1 \times 10^5$  Rads (Si) total dose. No compensation in gate drive circuitry is required. These devices are also capable of surviving transient ionization pulses as high as  $1 \times 10^{12}$  Rads (Si)/Sec, and return to normal operation within a few microseconds. Since the RAD HARD process utilizes International Rectifier's patented HEXFET technology, the user can expect the highest quality and reliability in the industry.

RAD HARD HEXFET transistors also feature all of the well-established advantages of MOSFETs, such as voltage control, very fast switching, ease of paralleling and temperature stability of the electrical parameters. They are well-suited for applications such as switching power supplies, motor controls, inverters, choppers, audio amplifiers and high-energy pulse circuits in space and weapons environments.

### Product Summary

| Part Number | BV <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-------------|-------------------|---------------------|----------------|
| IRHNA7Z60   | 30V               | 0.009W              | 75*A           |
| IRHNA8Z60   | 30V               | 0.009W              | 75*A           |

### Features:

- Radiation Hardened up to  $1 \times 10^6$  Rads (Si)
- Single Event Burnout (SEB) Hardened
- Single Event Gate Rupture (SEGR) Hardened
- Gamma Dot (Flash X-Ray) Hardened
- Neutron Tolerant
- Identical Pre- and Post-Electrical Test Conditions
- Repetitive Avalanche Rating
- Dynamic  $dv/dt$  Rating
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Surface Mount
- LightWeight

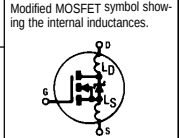
### Absolute Maximum Ratings

### Pre-Irradiation

|                                                                 | Parameter                            | IRHNA7Z60, IRHNA8Z60 | Units |
|-----------------------------------------------------------------|--------------------------------------|----------------------|-------|
| I <sub>D</sub> @ V <sub>GS</sub> = -12V, T <sub>C</sub> = 25°C  | Continuous Drain Current             | 75*                  | A     |
| I <sub>D</sub> @ V <sub>GS</sub> = -12V, T <sub>C</sub> = 100°C | Continuous Drain Current             | 75*                  |       |
| I <sub>DM</sub>                                                 | Pulsed Drain Current ①               | 300                  |       |
| P <sub>D</sub> @ T <sub>C</sub> = 25°C                          | Max. Power Dissipation               | 300                  | W     |
|                                                                 | Linear Derating Factor               | 2.4                  | W/°C  |
| V <sub>GS</sub>                                                 | Gate-to-Source Voltage               | ± 20                 | V     |
| EAS                                                             | Single Pulse Avalanche Energy ②      | 500                  | mJ    |
| I <sub>AR</sub>                                                 | Avalanche Current ①                  | 75                   | A     |
| EAR                                                             | Repetitive Avalanche Energy ①        | 30                   | mJ    |
| dv/dt                                                           | Peak Diode Recovery dv/dt ③          | 0.35                 | V/ns  |
| T <sub>J</sub>                                                  | Operating Junction                   | -55 to 150           | °C    |
| T <sub>STG</sub>                                                | Storage Temperature Range            |                      |       |
|                                                                 | Package Mounting surface Temperature | 300 (for 5 sec.)     |       |
|                                                                 | Weight                               | 3.3 (typical)        | g     |

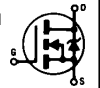
Electrical Characteristics @ T<sub>j</sub> = 25°C (Unless Otherwise Specified)

|                                     | 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                                       |
| dBV <sub>DSS</sub> /DT <sub>j</sub> | Temperature Coefficient of Breakdown Voltage | —   | 0.023 | —     | V/°C  | Reference to 25°C, I <sub>D</sub> = 1.0mA                                          |
| R <sub>DS(on)</sub>                 | Static Drain-to-Source On-State Resistance   | —   | —     | 0.009 |       | V <sub>GS</sub> = 12V, I <sub>D</sub> = 75A 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                     | 31  | —     | —     | S (M) | V <sub>DS</sub> > 15V, I <sub>DS</sub> = 75A ④                                     |
| I <sub>DSS</sub>                    | Zero Gate Voltage Drain Current              | —   | —     | 25    | mA    | V <sub>DS</sub> = 0.8 x Max Rating, V <sub>GS</sub> = 0V                           |
|                                     |                                              | —   | —     | 250   |       | V <sub>DS</sub> = 0.8 x Max Rating<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                            | —   | —     | 421   | nC    | V <sub>GS</sub> = 12V, I <sub>D</sub> = 75A<br>V <sub>DS</sub> = Max Rating x 0.5  |
| Q <sub>gs</sub>                     | Gate-to-Source Charge                        | —   | —     | 104   |       |                                                                                    |
| Q <sub>gd</sub>                     | Gate-to-Drain ('Miller') Charge              | —   | —     | 74    |       |                                                                                    |
| t <sub>d(on)</sub>                  | Turn-On Delay Time                           | —   | —     | 32    | ns    | V <sub>DD</sub> = 15V, I <sub>D</sub> = 75A,<br>R <sub>G</sub> = 2.35W             |
| t <sub>r</sub>                      | Rise Time                                    | —   | —     | 370   |       |                                                                                    |
| t <sub>d(off)</sub>                 | Turn-Off Delay Time                          | —   | —     | 150   |       |                                                                                    |
| t <sub>f</sub>                      | Fall Time                                    | —   | —     | 280   |       |                                                                                    |
| L <sub>D</sub>                      | Internal Drain Inductance                    | —   | 0.8   | —     | nH    | Measured from drain lead, 6mm (0.25 in) from package to center of die.             |
| L <sub>S</sub>                      | Internal Source Inductance                   | —   | 2.8   | —     |       | Measured from source lead, 6mm (0.25 in) from package to source bonding pad.       |
| C <sub>iss</sub>                    | Input Capacitance                            | —   | 7000  | —     | pF    | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V<br>f = 1.0MHz                          |
| C <sub>oss</sub>                    | Output Capacitance                           | —   | 4800  | —     |       |                                                                                    |
| C <sub>rss</sub>                    | Reverse Transfer Capacitance                 | —   | 1800  | —     |       |                                                                                    |



## Source-Drain Diode Ratings and Characteristics

|                 | Parameter                              | Min                                                                                                                  | Typ | Max | Units | Test Conditions                                                             |
|-----------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----|-----|-------|-----------------------------------------------------------------------------|
| I <sub>S</sub>  | Continuous Source Current (Body Diode) | —                                                                                                                    | —   | 75* | A     | Modified MOSFET symbol showing the integral reverse p-n junction rectifier. |
| I <sub>SM</sub> | Pulse Source Current (Body Diode) ①    | —                                                                                                                    | —   | 300 |       |                                                                             |
| V <sub>SD</sub> | Diode Forward Voltage                  | —                                                                                                                    | —   | 1.8 | V     | T <sub>j</sub> = 25°C, I <sub>S</sub> = 75A, V <sub>GS</sub> = 0V ④         |
| t <sub>rr</sub> | Reverse Recovery Time                  | —                                                                                                                    | —   | 245 | ns    | T <sub>j</sub> = 25°C, I <sub>F</sub> = 75A, di/dt £ 100A/ms                |
| Q <sub>RR</sub> | Reverse Recovery Charge                | —                                                                                                                    | —   | 1.1 | mC    | V <sub>DD</sub> £ 50V ④                                                     |
| 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     | —   | —   | 0.42 | °C/W  |                                           |
| R <sub>thJ-PCB</sub> | Junction-to-PC board | —   | 1.6 | —    |       | Soldered to a 1 inch square clad PC board |

\* Current is limited by internal wire diameter ( Die current is 75A , see page 6 )

## Radiation Performance of Rad Hard HEXFETs

International Rectifier Radiation Hardened HEXFETs are tested to verify their hardness capability. The hardness assurance program at International Rectifier comprises three radiation environments.

Every manufacturing lot is tested in a low dose rate (total dose) environment per MIL-STD-750, test method 1019 condition A. International Rectifier has imposed a standard gate condition of 12 volts per note 5 and a  $V_{DS}$  bias condition equal to 80% of the device rated voltage per note 6. Pre- and post- irradiation limits of the devices irradiated to  $1 \times 10^5$  Rads (Si) are identical and are presented in Table 1, column 1, IRHNA7Z60. Post-irradiation limits of the devices irradiated to  $1 \times 10^6$  Rads (Si) are presented in Table 1, column 2,

IRHNA8Z60. The values in Table 1 will be met for either of the two low dose rate test circuits that are used. 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.

High dose rate testing may be done on a special request basis using a dose rate up to  $1 \times 10^{12}$  Rads (Si)/Sec (See Table 2).

International Rectifier radiation hardened HEXFETs have been characterized in heavy ion Single Event Effects (SEE) environments. Single Event Effects characterization is shown in Table 3.

**Table 1. Low Dose Rate** ⑤ ⑥

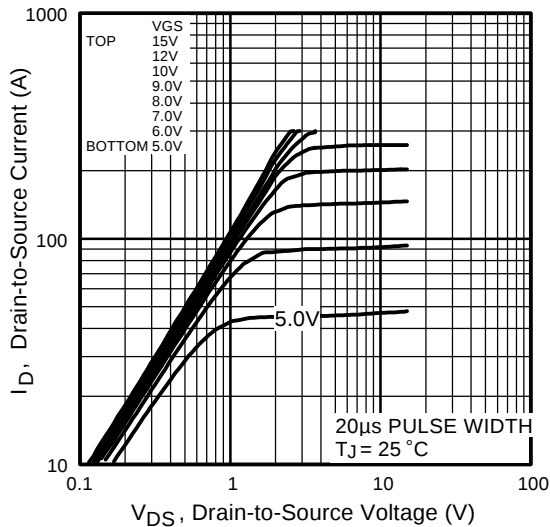
|               | Parameter                                           | IRHNA7Z60      |                 | IRHNA8Z60 |      | Units   | Test Conditions ⑧                                |
|---------------|-----------------------------------------------------|----------------|-----------------|-----------|------|---------|--------------------------------------------------|
|               |                                                     | 100K Rads (Si) | 1000K Rads (Si) | Min       | Max  |         |                                                  |
| $BV_{DSS}$    | Drain-to-Source Breakdown Voltage                   | 30             | —               | 30        | —    | V       | $V_{GS} = 0V, I_D = 1.0mA$                       |
| $V_{GS(th)}$  | Gate Threshold Voltage ④                            | 2.0            | 4.0             | 1.25      | 4.5  |         | $V_{GS} = V_{DS}, I_D = 1.0mA$                   |
| $I_{GSS}$     | Gate-to-Source Leakage Forward                      | —              | 100             | —         | 100  | nA      | $V_{GS} = 20V$                                   |
| $I_{GSS}$     | Gate-to-Source Leakage Reverse                      | —              | -100            | —         | -100 |         | $V_{GS} = -20V$                                  |
| $I_{DSS}$     | Zero Gate Voltage Drain Current                     | —              | 25              | —         | 50   | $\mu A$ | $V_{DS}=0.8 \times \text{Max Rating}, V_{GS}=0V$ |
| $R_{DS(on)1}$ | Static Drain-to-Source ④<br>On-State Resistance One | —              | .009            | —         | .03  | W       | $V_{GS} = 12V, I_D = 15A$                        |
| $V_{SD}$      | Diode Forward Voltage ④                             | —              | 1.8             | —         | 1.8  | V       | $T_C = 25^\circ C, I_S = 15A, V_{GS} = 0V$       |

**Table 2. High Dose Rate** ⑦

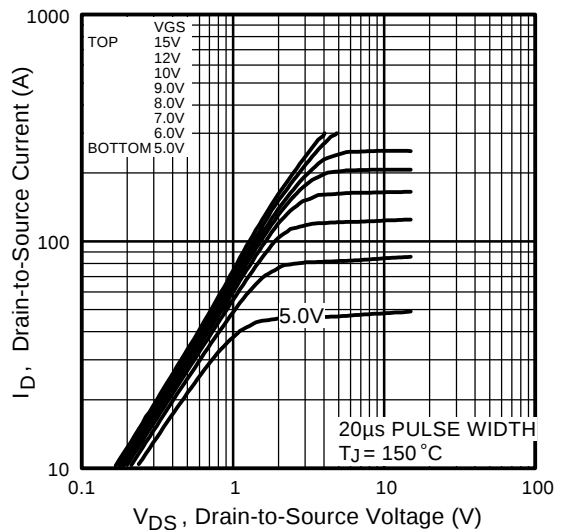
|           | Parameter               | $10^{11}$ Rads (Si)/sec |     |     | $10^{12}$ Rads (Si)/sec |     |     | Units        | Test Conditions                                  |
|-----------|-------------------------|-------------------------|-----|-----|-------------------------|-----|-----|--------------|--------------------------------------------------|
|           |                         | Min                     | Typ | Max | Min                     | Typ | Max |              |                                                  |
| $V_{DSS}$ | Drain-to-Source Voltage | —                       | —   | 24  | —                       | —   | 24  | V            | Applied drain-to-source voltage during gamma-dot |
| $I_{PP}$  |                         | —                       | 140 | —   | —                       | 140 | —   | A            | Peak radiation induced photo-current             |
| $di/dt$   |                         | —                       | 800 | —   | —                       | 160 | —   | A/ $\mu$ sec | Rate of rise of photo-current                    |
| $L_1$     |                         | 0.1                     | —   | —   | 0.8                     | —   | —   | $\mu H$      | Circuit inductance required to limit $di/dt$     |

**Table 3. Single Event Effects**

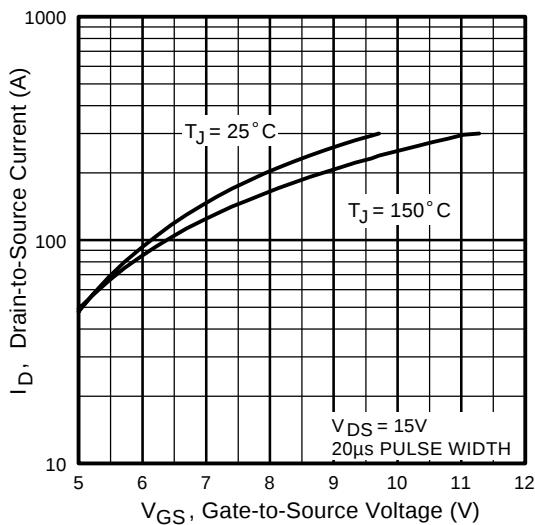
| Ion | LET (Si)<br>(MeV/mg/cm <sup>2</sup> ) | Fluence<br>(ions/cm <sup>2</sup> ) | Range<br>( $\mu$ m) | $V_{DS}$ Bias<br>(V) | $V_{GS}$ Bias<br>(V) |
|-----|---------------------------------------|------------------------------------|---------------------|----------------------|----------------------|
| Cu  | 28                                    | $3 \times 10^5$                    | 43                  | 26                   | -5                   |



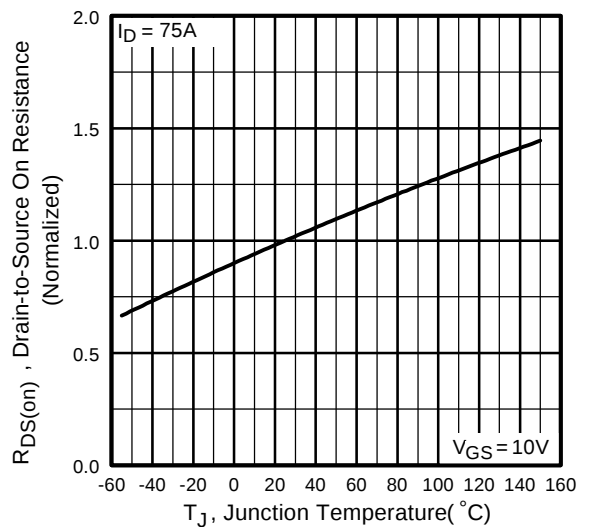
**Fig 1.** Typical Output Characteristics



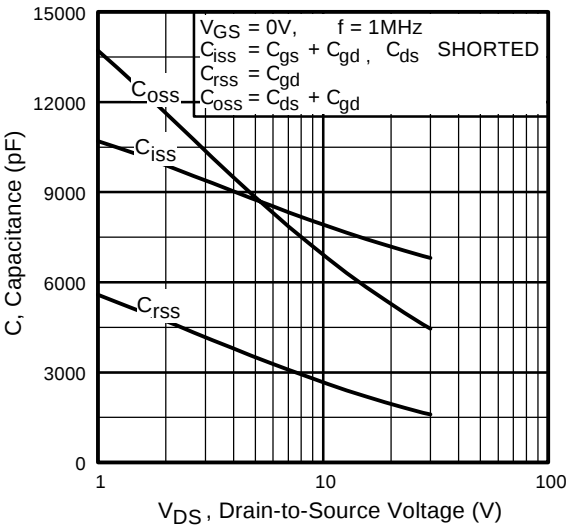
**Fig 2.** Typical Output Characteristics



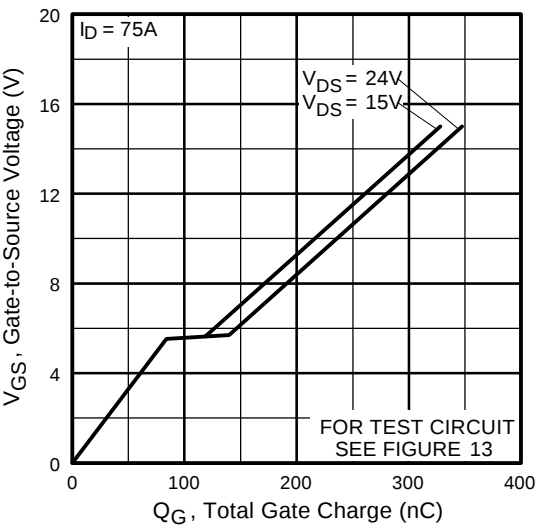
**Fig 3.** Typical Transfer Characteristics



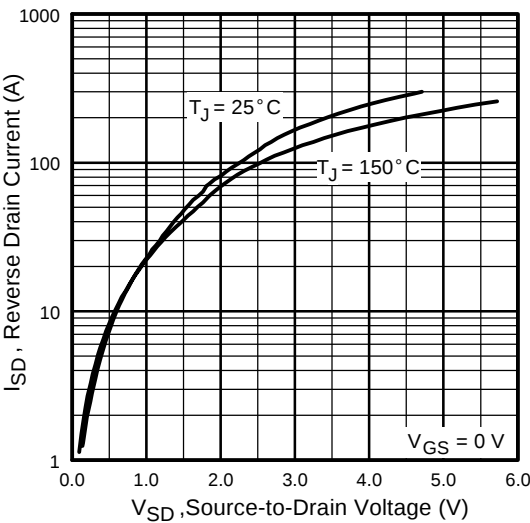
**Fig 4.** Normalized On-Resistance Vs. Temperature



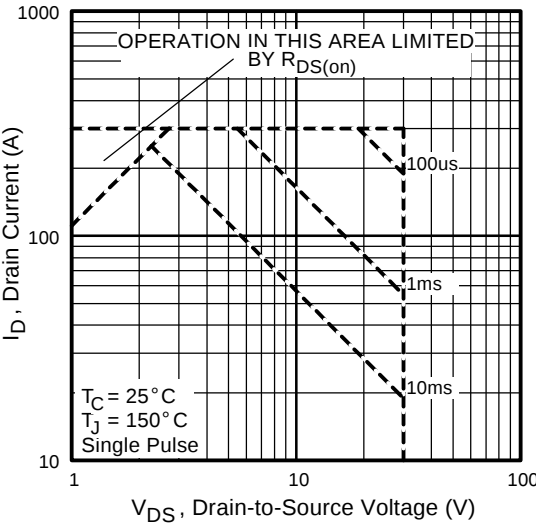
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



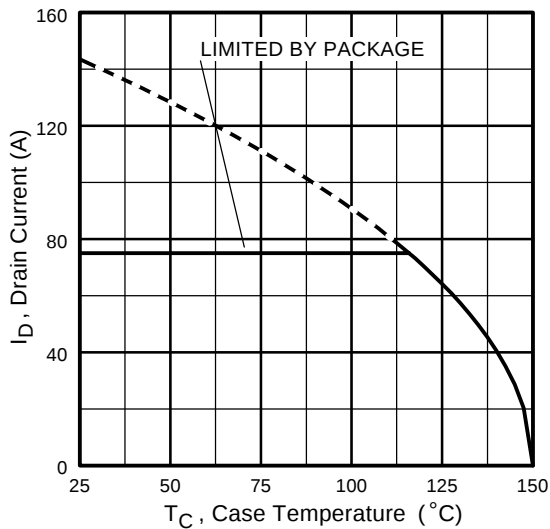
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



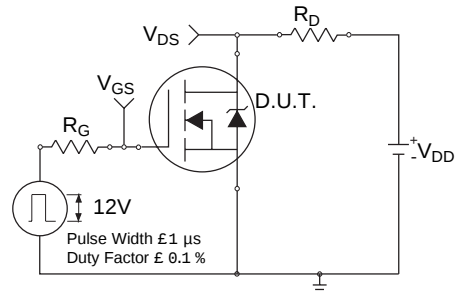
**Fig 7.** Typical Source-Drain Diode Forward Voltage



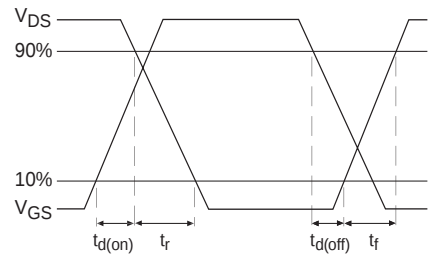
**Fig 8.** Maximum Safe Operating Area



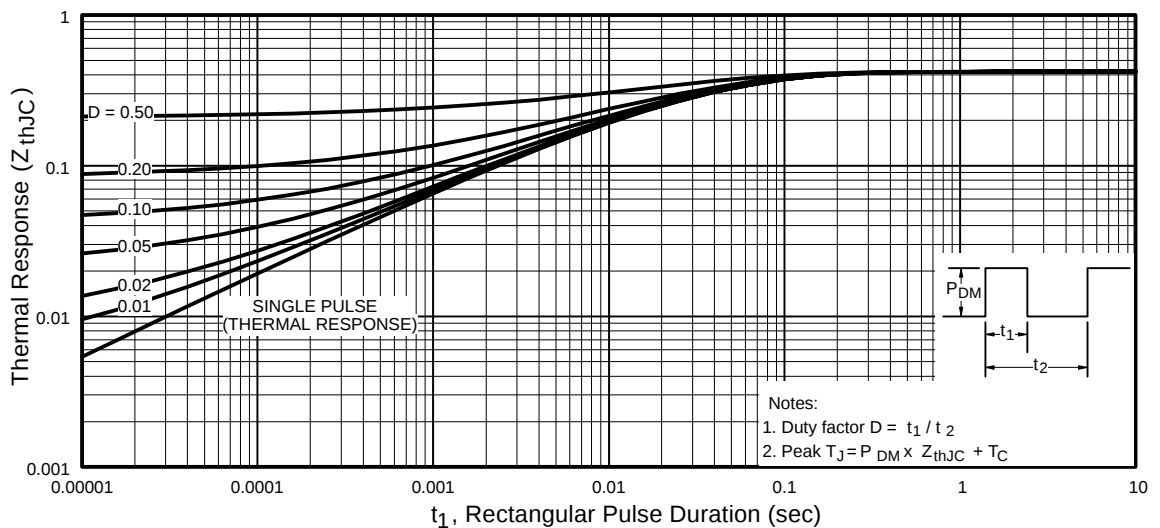
**Fig 9.** Maximum Drain Current Vs. Case Temperature



**Fig 10a.** Switching Time Test Circuit



**Fig 10b.** Switching Time Waveforms



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

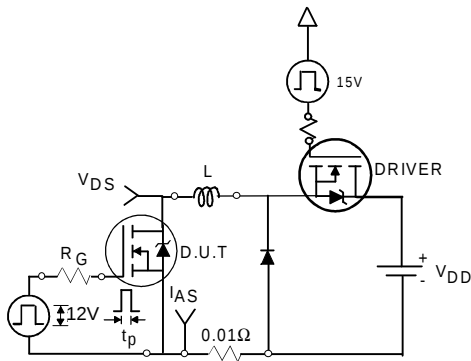


Fig 12a. Unclamped Inductive Test Circuit

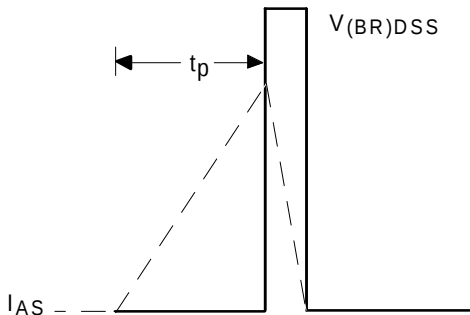


Fig 12b. Unclamped Inductive Waveforms

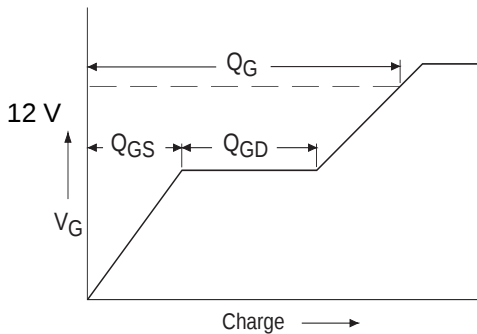


Fig 13a. Basic Gate Charge Waveform

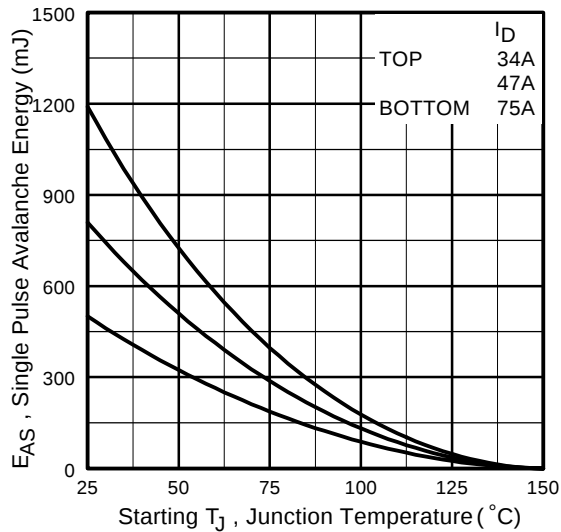


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

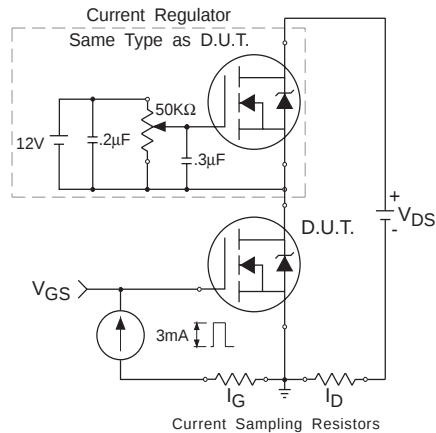


Fig 13b. Gate Charge Test Circuit

