

**RADIATION HARDENED  
 POWER MOSFET  
 THRU-HOLE (TO-39)**

**IRHF67230  
 200V, N-CHANNEL  
 TECHNOLOGY**

**Product Summary**

Part Number	Radiation Level	R <sub>DS(on)</sub>	I <sub>D</sub>
IRHF67230	100K Rads (Si)	0.145Ω	9.1A
IRHF63230	300K Rads (Si)	0.145Ω	9.1A



**TO-39**

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
- 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	9.1	A
I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 100°C	Continuous Drain Current	5.7	
I <sub>DM</sub>	Pulsed Drain Current ①	36.4	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Max. Power Dissipation	25	W
	Linear Derating Factor	0.2	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	23	mJ
I <sub>AR</sub>	Avalanche Current ①	9.1	A
E <sub>AR</sub>	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.8	V/ns
T <sub>J</sub>	Operating Junction	-55 to 150	°C
T <sub>STG</sub>	Storage Temperature Range		
	Lead Temperature	300 (0.063in/1.6mm from case for 10s)	
	Weight	0.98 (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	200	—	—	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	—	0.22	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.145	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 5.7A 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
ΔV <sub>GS(th)</sub> /ΔT <sub>J</sub>	Gate Threshold Voltage Coefficient	—	-9.6	—	mV/°C	
g <sub>fs</sub>	Forward Transconductance	5.0	—	—	S	V <sub>DS</sub> = 15V, I <sub>DS</sub> = 5.7A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	10	μA	V <sub>DS</sub> = 160V, V <sub>GS</sub> = 0V
		—	—	25		V <sub>DS</sub> = 160V, 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	—	—	45	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 9.1A
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	12		V <sub>DS</sub> = 100V
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	30		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	17	ns	V <sub>DD</sub> = 100V, I <sub>D</sub> = 9.1A, V <sub>GS</sub> = 12V, R <sub>G</sub> = 7.5Ω
t <sub>r</sub>	Rise Time	—	—	30		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	40		
t <sub>f</sub>	Fall Time	—	—	25		
LS + LD	Total Inductance	—	7.0	—	nH	Measured from Drain lead (6mm/0.25in from package) to Source lead (6mm/0.25in from package) with Source wire interannally bonded from Source pin to Drain pad
C <sub>iss</sub>	Input Capacitance	—	1374	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	214	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	4.2	—		
R <sub>g</sub>	Gate Resistance	—	1.1	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	9.1	A	T <sub>j</sub> = 25°C, I <sub>S</sub> = 9.1A, V <sub>GS</sub> = 0V ④
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	36.4		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.2	V	T <sub>j</sub> = 25°C, I <sub>F</sub> = 9.1A, di/dt ≤ 100A/μs
t <sub>rr</sub>	Reverse Recovery Time	—	—	317	ns	V <sub>DD</sub> ≤ 50V ④
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	2.91	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	—	—	5.0	°C/W	

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

For footnotes refer to the last page

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-39 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**

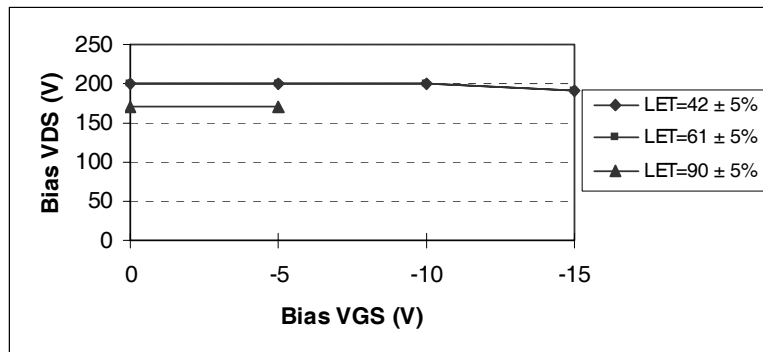
	Parameter	Upto 300K Rads(Si) <sup>1</sup>		Units	Test Conditions ⑧
		Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	200	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	4.0		V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0mA
I <sub>GSS</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	—	1.0	μA	V <sub>DS</sub> = 200V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-39)	—	0.145	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 5.7A
V <sub>SD</sub>	Diode Forward Voltage ④	—	1.2	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 9.1A

1. Part numbers IRHF67230, IRHF63230

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. Typical Single Event Effect Safe Operating Area**

LET (MeV/(mg/cm <sup>2</sup> ))	Energy (MeV)	Range (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
42 ± 5%	2450 ± 5%	205 ± 5%	200	200	200	190
61 ± 5%	825 ± 5%	66 ± 7.5%	200	200	200	190
90 ± 5%	1470 ± 5%	80 ± 5%	170	170	-	-



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

For footnotes refer to the last page

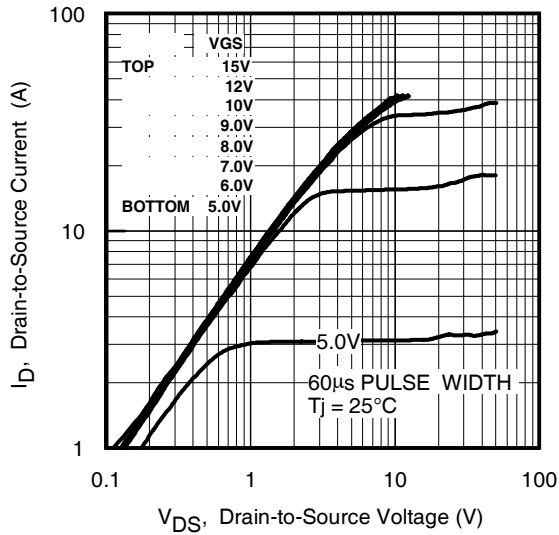


Fig 1. Typical Output Characteristics

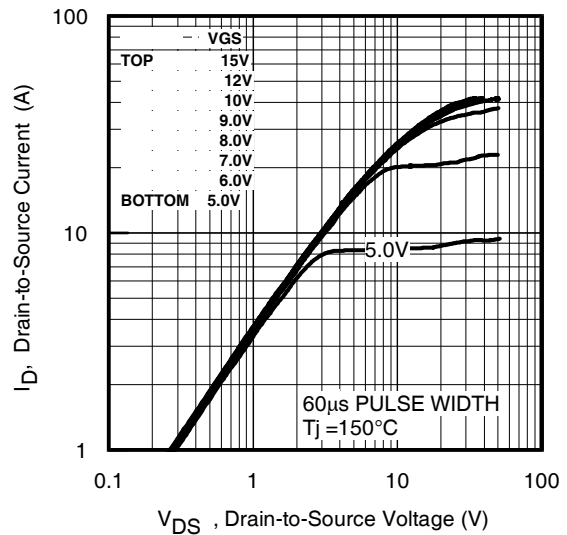


Fig 2. Typical Output Characteristics

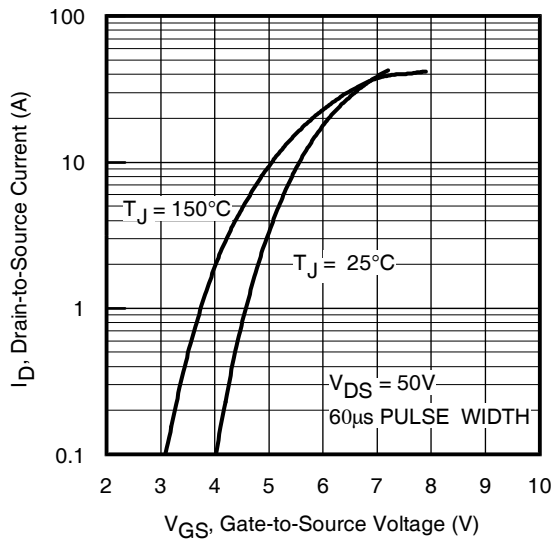


Fig 3. Typical Transfer Characteristics

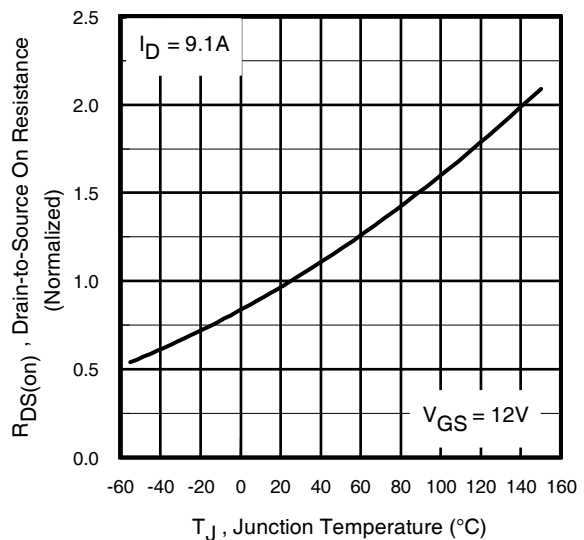
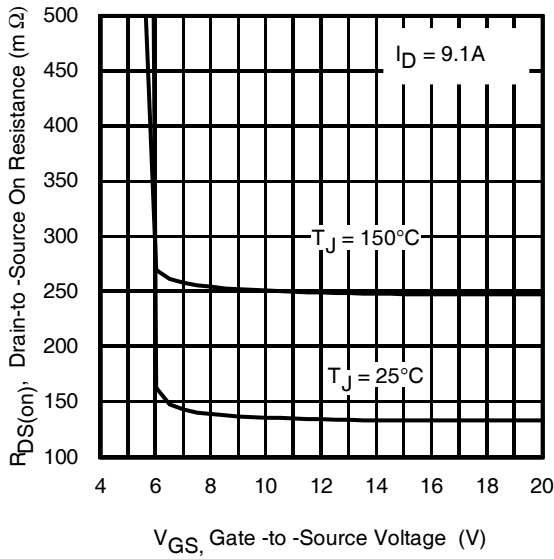
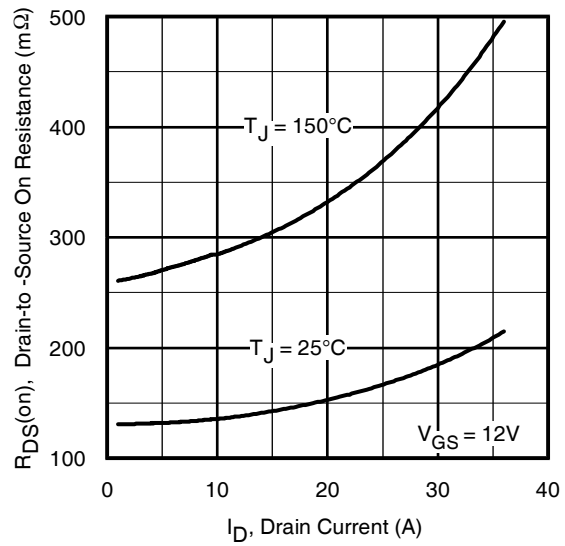


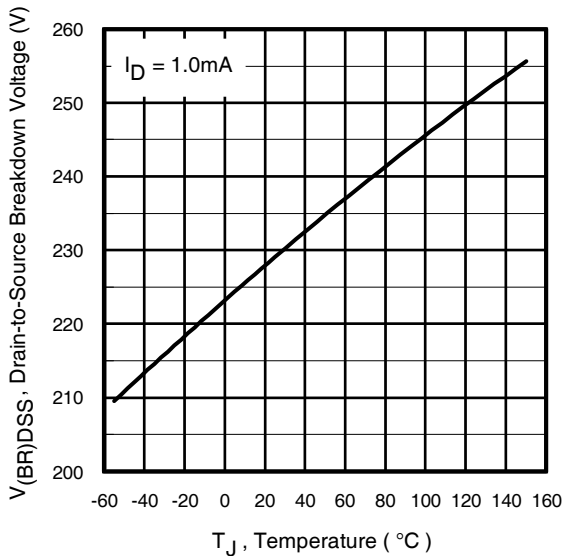
Fig 4. Normalized On-Resistance Vs. Temperature



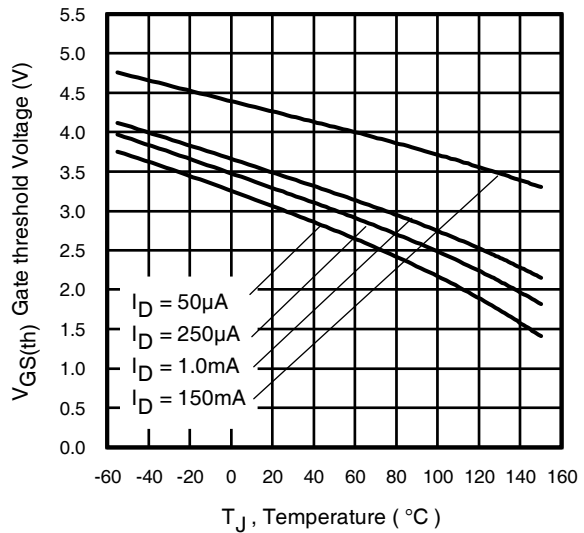
**Fig 5.** Typical On-Resistance Vs Gate Voltage



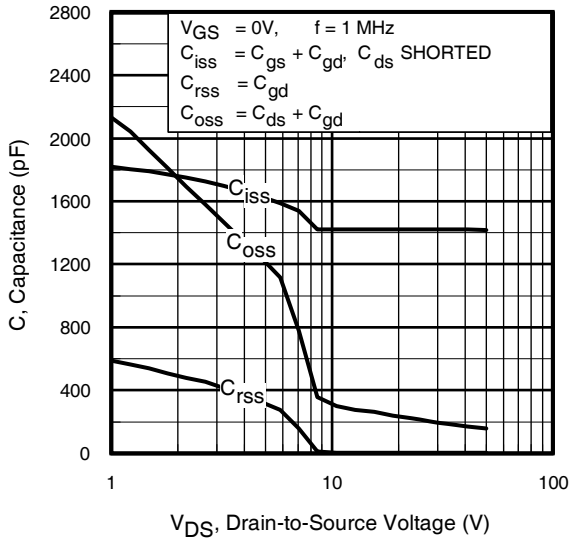
**Fig 6.** Typical On-Resistance Vs Drain Current



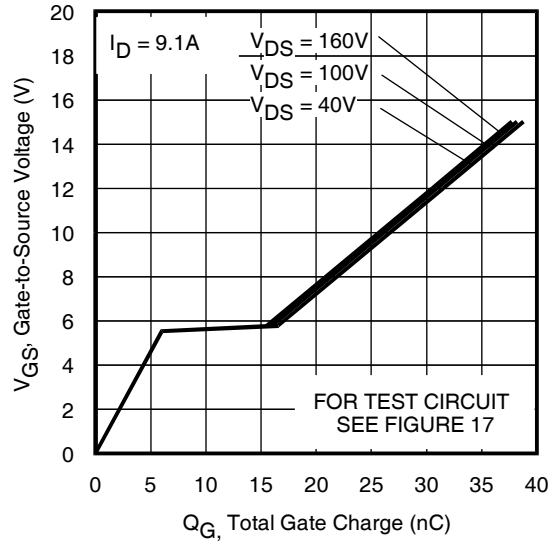
**Fig 7.** Typical Drain-to-Source Breakdown Voltage Vs Temperature



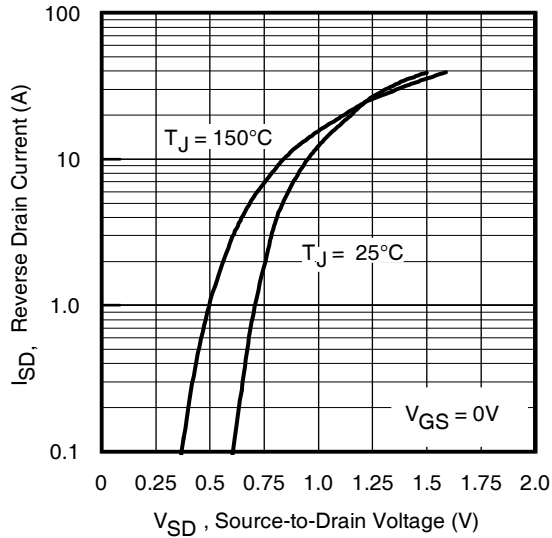
**Fig 8.** Typical Threshold Voltage Vs Temperature



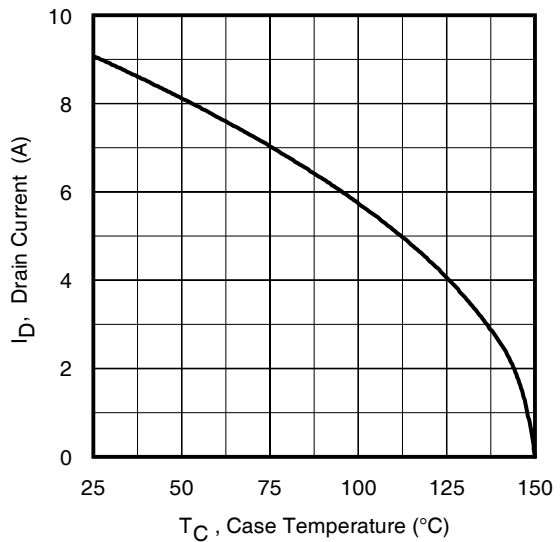
**Fig 9.** Typical Capacitance Vs. Drain-to-Source Voltage



**Fig 10.** Typical Gate Charge Vs. Gate-to-Source Voltage



**Fig 11.** Typical Source-Drain Diode Forward Voltage



**Fig 12.** Maximum Drain Current Vs. Case Temperature

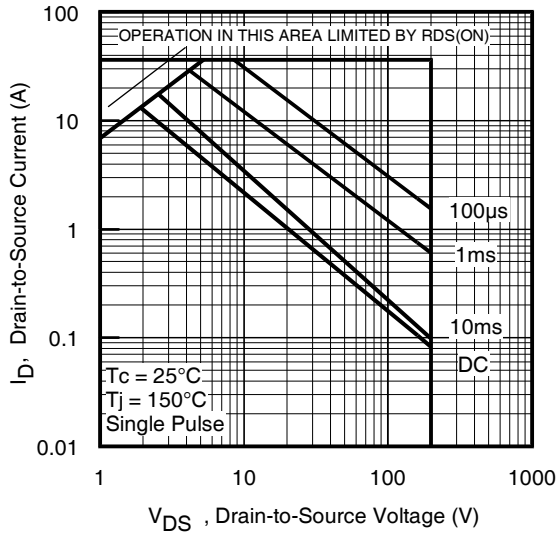


Fig 13. Maximum Safe Operating Area

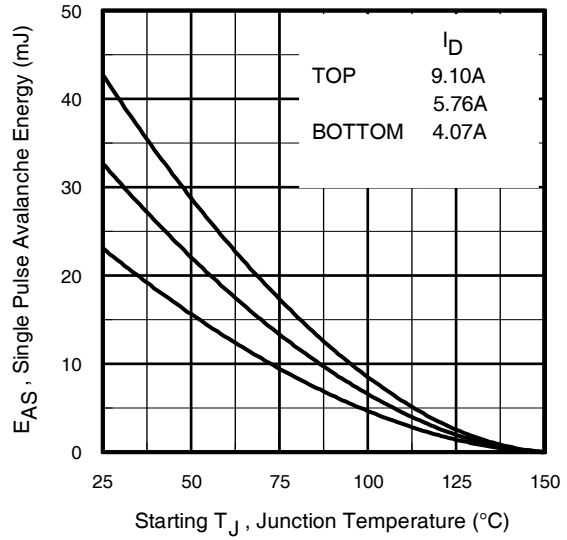


Fig 14. Maximum Avalanche Energy Vs. Drain Current

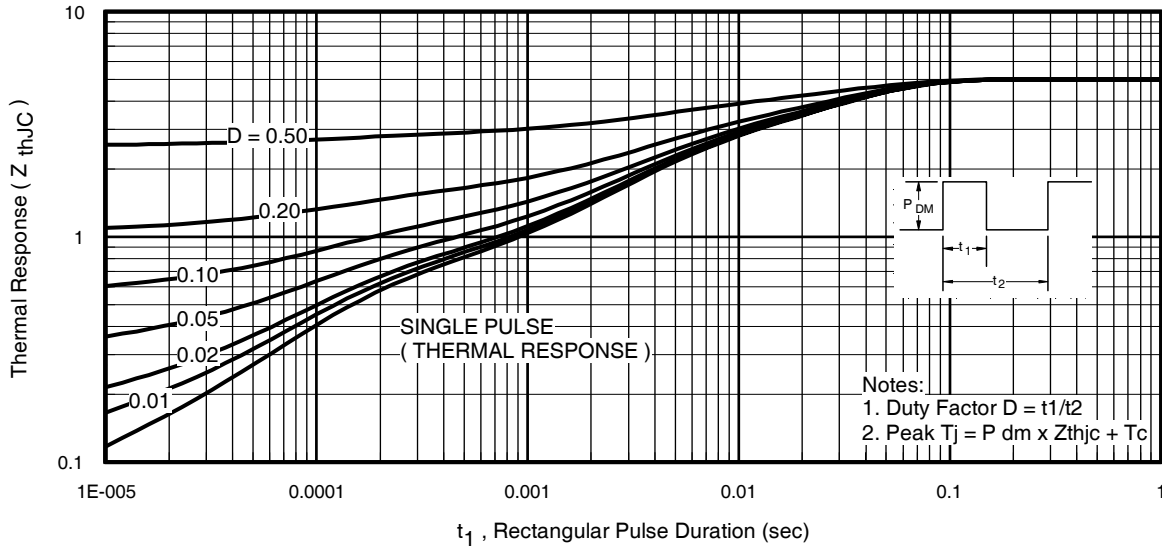


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

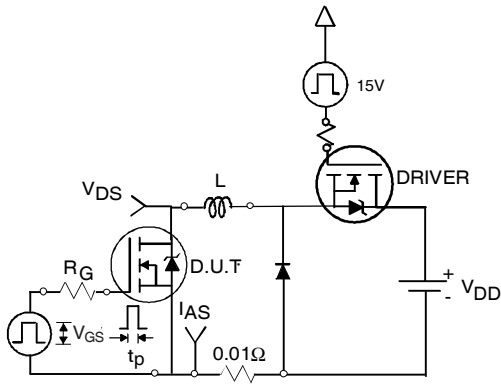


Fig 16a. Unclamped Inductive Test Circuit

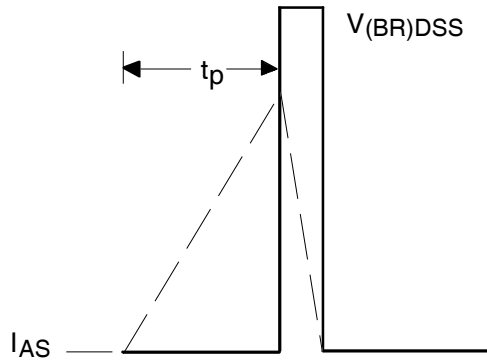


Fig 16b. Unclamped Inductive Waveforms

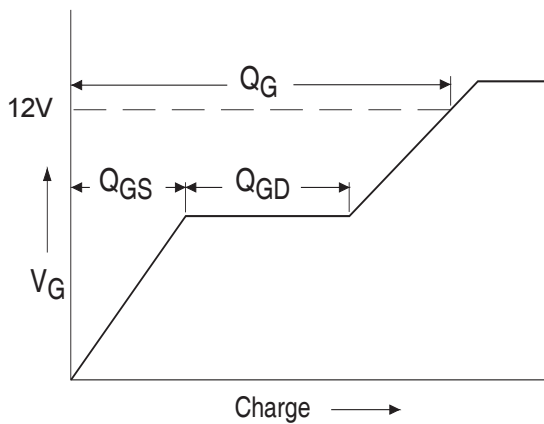


Fig 17a. Basic Gate Charge Waveform

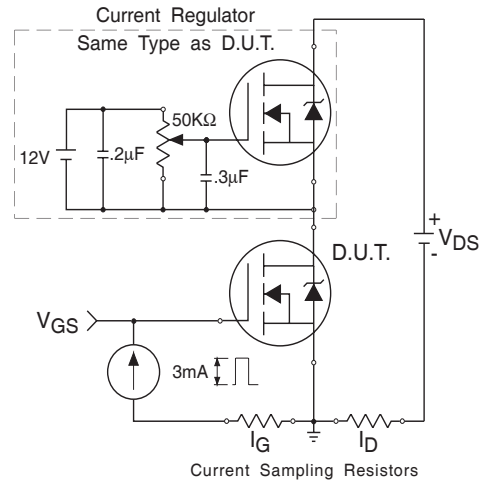


Fig 17b. Gate Charge Test Circuit

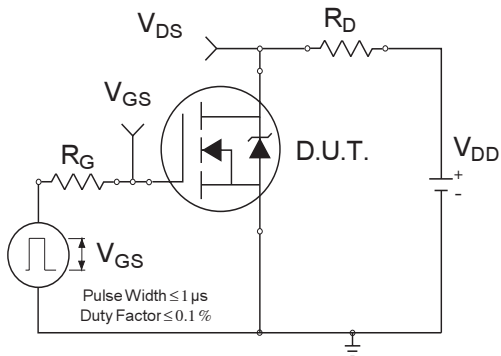


Fig 18a. Switching Time Test Circuit

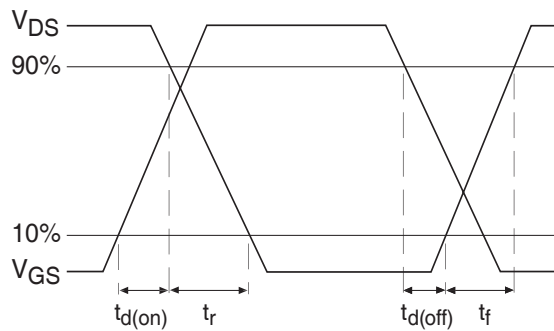


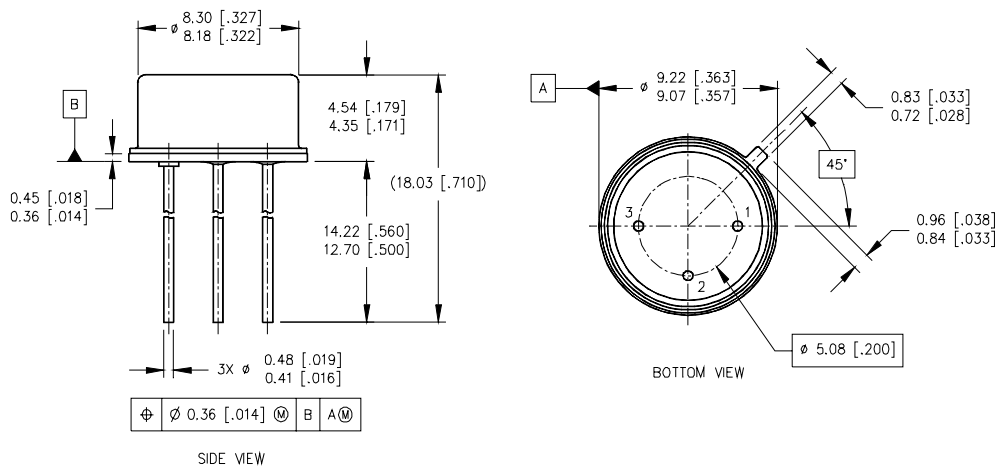
Fig 18b. Switching Time Waveforms



**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 50V$ , starting  $T_J = 25^\circ C$ ,  $L = 0.56mH$   
Peak  $I_L = 9.1A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 9.1A$ ,  $di/dt \leq 347A/\mu s$ ,  
 $V_{DD} \leq 200V$ ,  $T_J \leq 150^\circ C$
- 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.**  
160 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Case Outline and Dimensions — TO-205AF (Modified TO-39)**



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME 14.5M-1994.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. CONTROLLING DIMENSION: INCH.
4. CONFORMS TO JEDEC OUTLINE TO-205AF (TO-39).

**LEGEND**

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

International  
**IR** Rectifier

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