

# International IR Rectifier

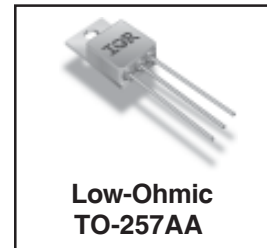
PD-96911

## RADIATION HARDENED POWER MOSFET THRU-HOLE (Low-Ohmic TO-257AA)

**IRHYS597034CM**  
**60V, P-CHANNEL**  
**R5 TECHNOLOGY**

### Product Summary

Part Number	Radiation Level	RDS(on)	ID
IRHYS597034CM	100K Rads (Si)	0.087Ω	-20A
IRHYS593034CM	300K Rads (Si)	0.087Ω	-20A



International Rectifier's R5™ technology provides high performance power MOSFETs for space applications. These devices have been characterized for Single Event Effects (SEE) with useful performance up to an LET of 80 (MeV/(mg/cm<sup>2</sup>)). The combination of low RDS(on) 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:

- Low RDS(on)
- Fast Switching
- Single Event Effect (SEE) Hardened
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Eyelets
- Electrically Isolated
- Light Weight

### Absolute Maximum Ratings

### Pre-Irradiation

	Parameter		Units
ID @ VGS = -12V, TC = 25°C	Continuous Drain Current	-20	A
ID @ VGS = -12V, TC = 100°C	Continuous Drain Current	-13	
IDM	Pulsed Drain Current ①	-80	
PD @ TC = 25°C	Max. Power Dissipation	75	W
	Linear Derating Factor	0.6	W/°C
VGS	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	134	mJ
IAR	Avalanche Current ①	-20	A
EAR	Repetitive Avalanche Energy ①	7.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-4.9	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	Lead Temperature	300 (0.063in./1.6mm from case for 10s)	
	Weight	4.3 ( Typical )	g

For footnotes refer to the last page

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**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	-60	—	—	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	—	-0.066	—	V/°C	Reference to 25°C, I <sub>D</sub> = -1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.087	Ω	V <sub>GS</sub> = -12V, I <sub>D</sub> = -13A 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	10	—	—	S (⑤)	V <sub>DS</sub> = -15V, I <sub>DS</sub> = -13A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	-10	μA	V <sub>DS</sub> = -48V, V <sub>GS</sub> = 0V
		—	—	-25		V <sub>DS</sub> = -48V, 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> = -20A
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	18		V <sub>DS</sub> = -30V
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	13		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	25	ns	V <sub>DD</sub> = -30V, I <sub>D</sub> = -20A
t <sub>r</sub>	Rise Time	—	—	65		V <sub>GS</sub> = -12V, R <sub>G</sub> = 7.5Ω
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	75		
t <sub>f</sub>	Fall Time	—	—	50		
LS + LD	Total Inductance	—	6.8	—	nH	Measured from Drain lead (6mm / 0.25in. from package) to Source lead (6mm / 0.25in. from package)
C <sub>iss</sub>	Input Capacitance	—	1560	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = -25V
C <sub>oss</sub>	Output Capacitance	—	565	—		f = 1.0MHz
C <sub>rss</sub>	Reverse Transfer Capacitance	—	62	—		
R <sub>g</sub>	Internal Gate Resistance	—	6.5	—		Ω

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	-20	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	-80		
V <sub>SD</sub>	Diode Forward Voltage	—	—	-5.0	V	T <sub>j</sub> = 25°C, I <sub>S</sub> = -20A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	100	ns	T <sub>j</sub> = 25°C, I <sub>F</sub> = -20A, di/dt ≤ -100A/μs
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	200	nC	V <sub>DD</sub> ≤ -25V ④
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by LS + LD.				

**Thermal Resistance**

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	1.67	°C/W	
R <sub>thJA</sub>	Junction-to-Ambient	—	—	80		Typical Socket Mount

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

For footnotes refer to the last page

## Radiation Characteristics

IRHYS597034CM

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	100KRads(Si) <sup>1</sup>		300KRads(Si) <sup>2</sup>		Units	Test Conditions
		Min	Max	Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	-60	—	-60	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = -1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	-2.0	-4.0	-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	—	-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	—	-10	μA	V <sub>DS</sub> = -48V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance (TO-3)	—	0.087	—	0.087	Ω	V <sub>GS</sub> = -12V, I <sub>D</sub> = -13A
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance(Low-OhmicTO-257AA)	—	0.087	—	0.087	Ω	V <sub>GS</sub> = -12V, I <sub>D</sub> = -13A
V <sub>SP</sub>	Diode Forward Voltage	—	-5.0	—	-5.0	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = -20A

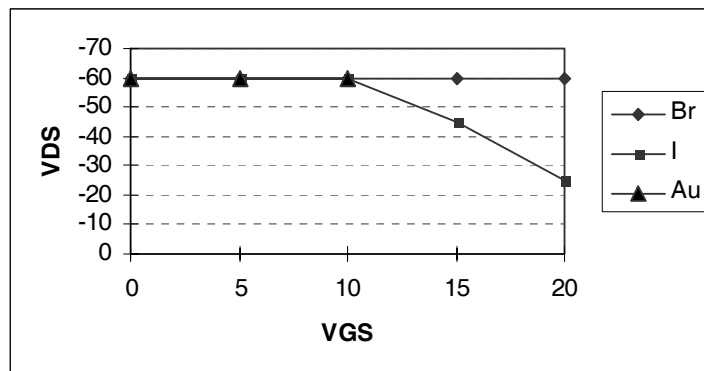
1. Part number IRHYS597034CM

2. Part number IRHYS593034CM

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 (MeV/(mg/cm <sup>2</sup> ))	Energy (MeV)	Range (μm)	VDS (V)				
				@VGS=0V	@VGS=5V	@VGS=10V	@VGS=15V	@VGS=20V
Br	37.9	252.6	33.1	- 60	- 60	- 60	- 60	- 60
I	59.7	314	30.5	- 60	- 60	- 60	- 45	- 25
Au	82.3	350	28.4	- 60	- 60	- 60	—	—



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

For footnotes refer to the last page

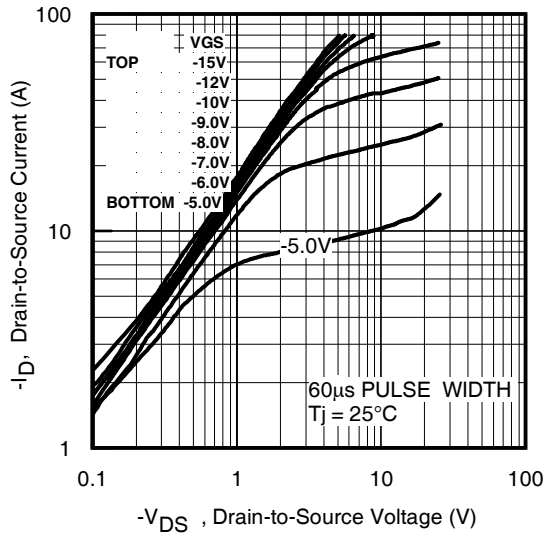


Fig 1. Typical Output Characteristics

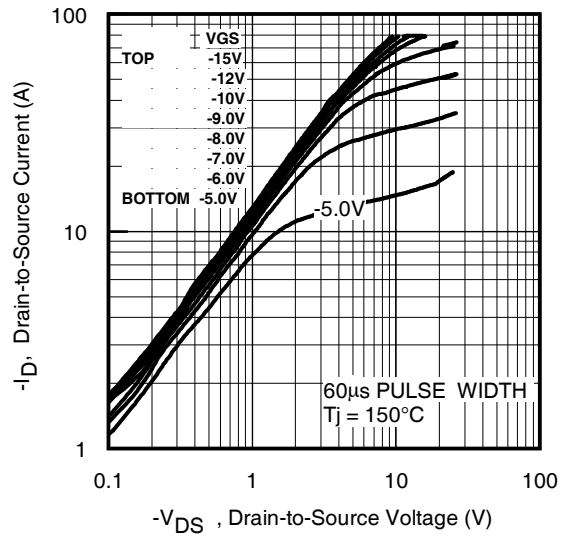


Fig 2. Typical Output Characteristics

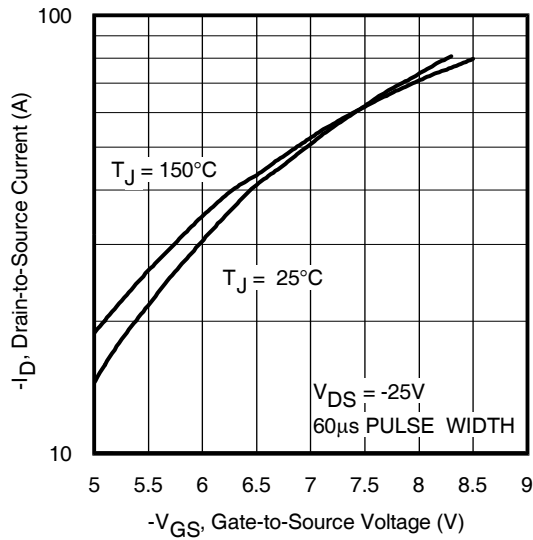


Fig 3. Typical Transfer Characteristics

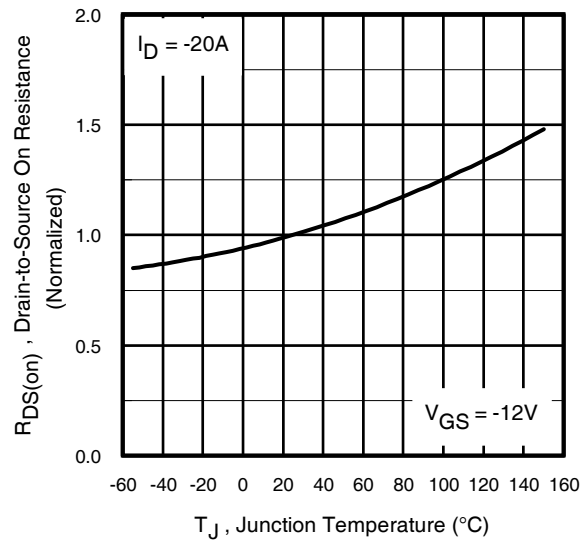


Fig 4. Normalized On-Resistance Vs. Temperature

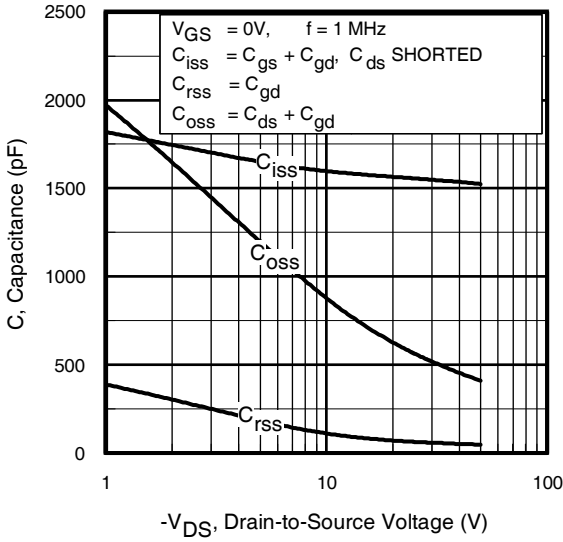


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

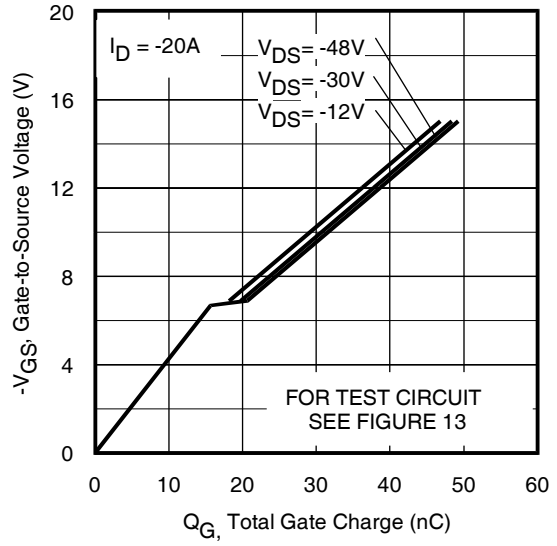


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

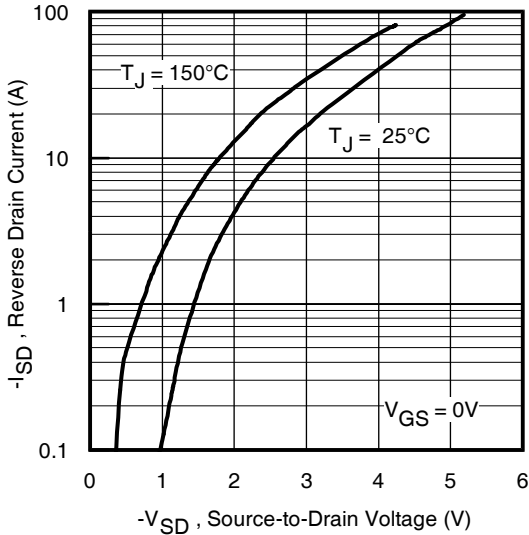


Fig 7. Typical Source-Drain Diode Forward Voltage

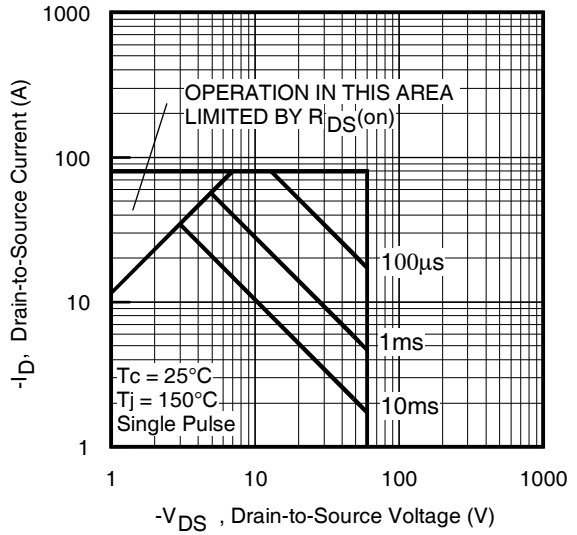


Fig 8. Maximum Safe Operating Area

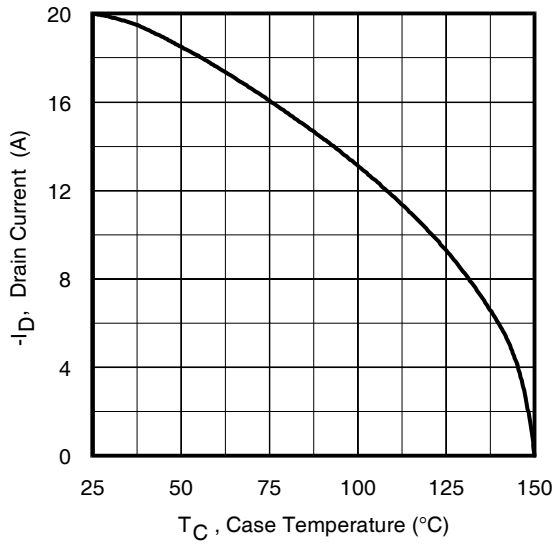


Fig 9. Maximum Drain Current Vs. Case Temperature

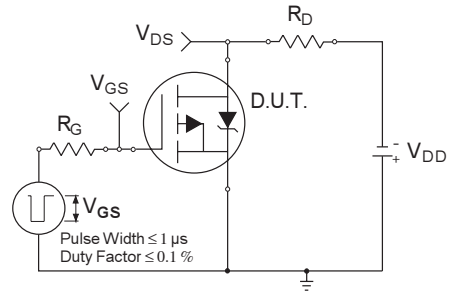


Fig 10a. Switching Time Test Circuit

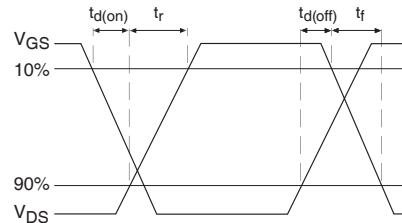


Fig 10b. Switching Time Waveforms

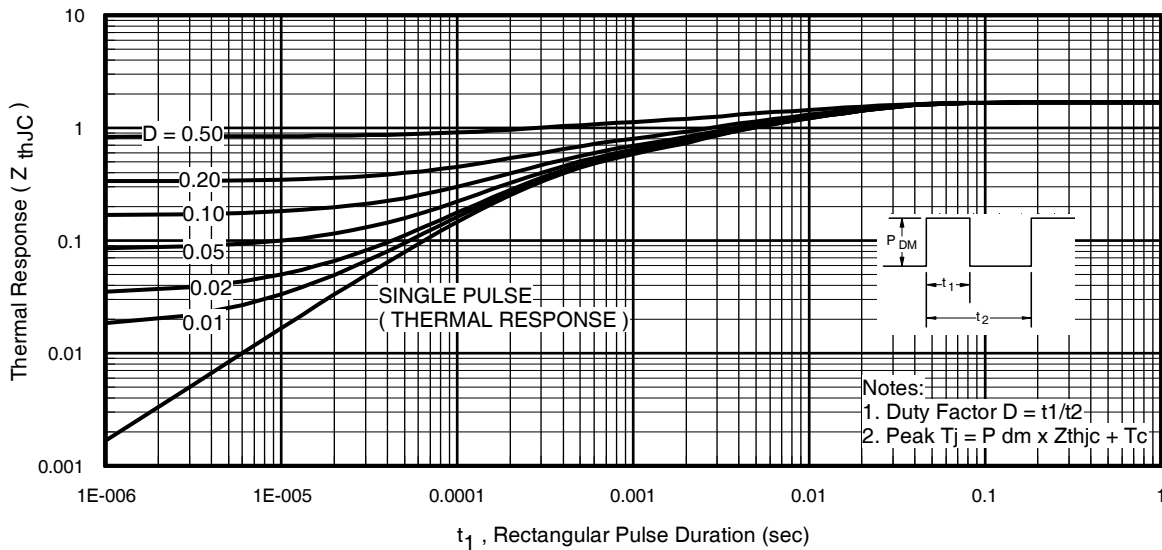


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

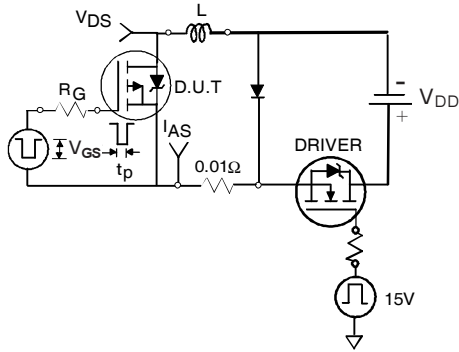


Fig 12a. Unclamped Inductive Test Circuit

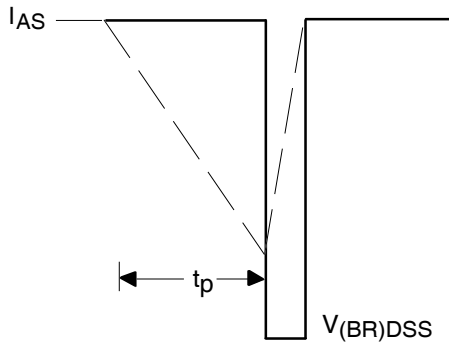


Fig 12b. Unclamped Inductive Waveforms

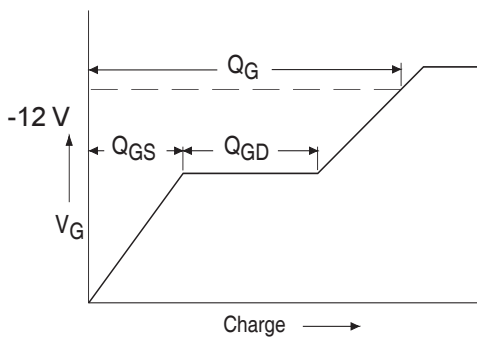


Fig 13a. Basic Gate Charge Waveform

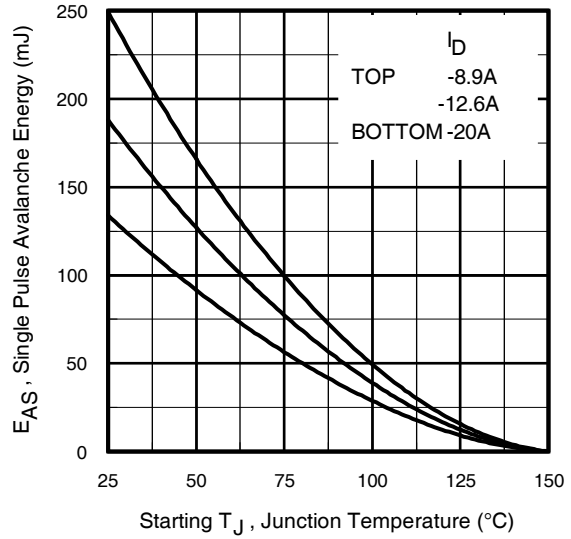


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

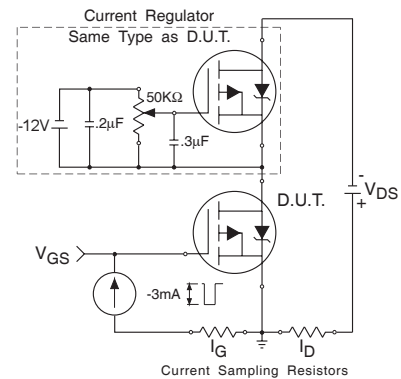
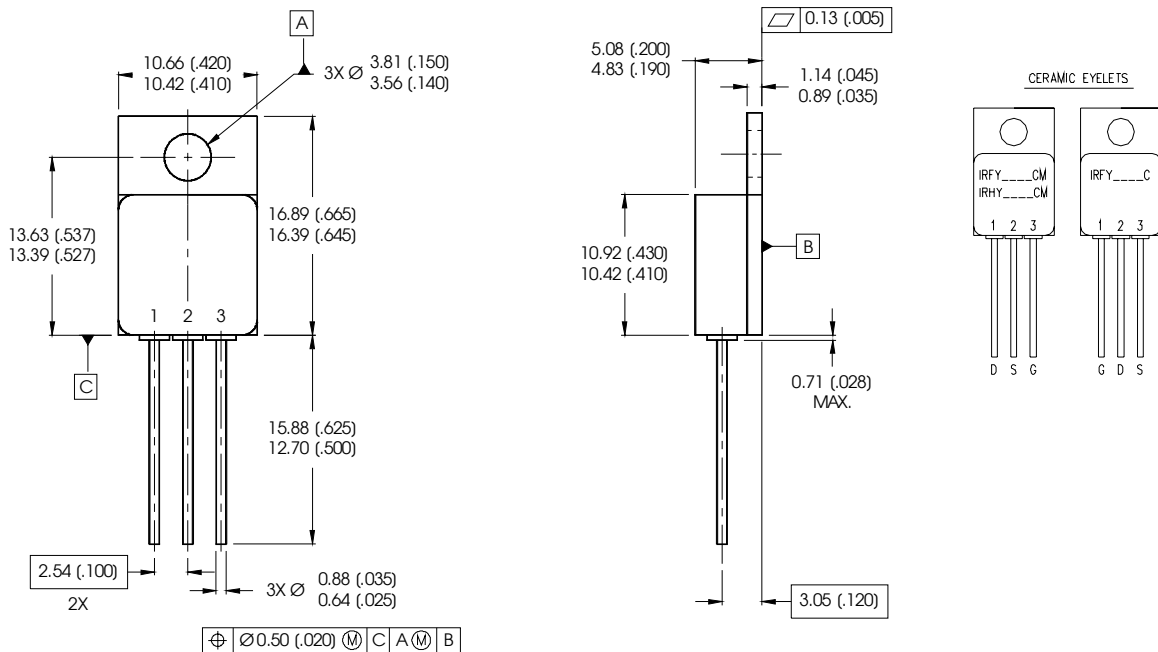


Fig 13b. Gate Charge Test Circuit

**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = -25V$ , starting  $T_J = 25^\circ C$ ,  $L=0.67mH$   
Peak  $I_L = -20A$ ,  $V_{GS} = -12V$
- ③  $I_{SD} \leq -20A$ ,  $di/dt \leq -370A/\mu s$ ,  
 $V_{DD} \leq -60V$ ,  $T_J \leq 150^\circ C$
- 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.**  
-48 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Case Outline and Dimensions — Low-Ohmic TO-257AA**



**NOTES:**

- 1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1994.
- 2. CONTROLLING DIMENSION: INCH.
- 3. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
- 4. TO-257AA TABLESS IS A MODIFIED JEDEC OUTLINE TO-257AA.

**LEAD ASSIGNMENTS**

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



**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
**IR LEOMINSTER :** 205 Crawford St., Leominster, Massachusetts 01453, USA Tel: (978) 534-5776  
 TAC Fax: (310) 252-7903

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