

# International IR Rectifier

PD - 93793A

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

## IRHF57Z30 30V, N-CHANNEL R5 TECHNOLOGY

### Product Summary

Part Number	Radiation Level	RDS(on)	ID
IRHF57Z30	100K Rads (Si)	0.045Ω	12A*
IRHF53Z30	300K Rads (Si)	0.045Ω	12A*
IRHF54Z30	600K Rads (Si)	0.045Ω	12A*
IRHF58Z30	1000K Rads (Si)	0.056Ω	12A*



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:

- Single Event Effect (SEE) Hardened
- Ultra Low RDS(on)
- Neutron Tolerant
- Identical Pre and Post Electrical Test Conditions
- Repetitive Avalanche Ratings
- Dynamic dv/dt Ratings
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Electrically Isolated

### Absolute Maximum Ratings

### Pre-Irradiation

	Parameter		Units
ID @ VGS = 12V, TC = 25°C	Continuous Drain Current	12*	A
ID @ VGS = 12V, TC = 100°C	Continuous Drain Current	10	
IDM	Pulsed Drain Current ①	48	
PD @ TC = 25°C	Max. Power Dissipation	25	W
	Linear Derating Factor	0.2	W/°C
VGS	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	520	mJ
IAR	Avalanche Current ①	12	A
EAR	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.0	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	Lead Temperature	300 ( 0.063 in./1.6mm from case for 10s)	
	Weight	0.98 (Typical)	g

\* Current is limited by internal wire diameter  
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
BVDSS	Drain-to-Source Breakdown Voltage	30	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔBVDSS/ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.03	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
RDS(on)	Static Drain-to-Source On-State Resistance	—	—	0.045	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 10A ④
VGS(th)	Gate Threshold Voltage	2.0	—	4.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1.0mA
gfs	Forward Transconductance	12	—	—	S (Ω)	V <sub>DS</sub> > 15V, I <sub>DS</sub> = 10A ④
IDSS	Zero Gate Voltage Drain Current	—	—	10	μA	V <sub>DS</sub> = 24V, V <sub>GS</sub> = 0V
		—	—	25		V <sub>DS</sub> = 24V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
IGSS	Gate-to-Source Leakage Forward	—	—	100	nA	V <sub>GS</sub> = 20V
IGSS	Gate-to-Source Leakage Reverse	—	—	-100	nA	V <sub>GS</sub> = -20V
Qg	Total Gate Charge	—	—	65	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 12A V <sub>DS</sub> = 15V
Qgs	Gate-to-Source Charge	—	—	20		
Qgd	Gate-to-Drain ('Miller') Charge	—	—	10		
td(on)	Turn-On Delay Time	—	—	25	ns	V <sub>DD</sub> = 15V, I <sub>D</sub> = 12A V <sub>GS</sub> = 12V, R <sub>G</sub> = 7.5Ω
tr	Rise Time	—	—	100		
td(off)	Turn-Off Delay Time	—	—	35		
tf	Fall Time	—	—	30		
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 wires internally bonded from Source Pin to Drain Pad
Ciss	Input Capacitance	—	2055	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
Coss	Output Capacitance	—	936	—		
Crss	Reverse Transfer Capacitance	—	35	—		

## Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	12*	A	T <sub>j</sub> = 25°C, I <sub>S</sub> = 12A, V <sub>GS</sub> = 0V ④
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	48		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.5	V	T <sub>j</sub> = 25°C, I <sub>F</sub> = 12A, di/dt ≤ 100A/μs
t <sub>rr</sub>	Reverse Recovery Time	—	—	92	ns	V <sub>DD</sub> ≤ 25V ④
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	194	nC	
ton	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by LS + LD.				

\* Current is limited by internal wire diameter

## Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	5.0	°C/W	Typical socket mount
R <sub>thJA</sub>	Junction-to-Ambient	—	—	175		

Note: Corresponding Spice and Saber models are available on the G&S Website.

For footnotes refer to the last page

## Radiation Characteristics

## IRHF57Z30

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	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> = -20V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	10	—	10	μA	V <sub>DS</sub> = 24V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.024	—	0.03	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 10A
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-39)	—	0.045	—	0.056	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 10A
V <sub>SD</sub>	Diode Forward Voltage ④	—	1.5	—	1.5	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 12A

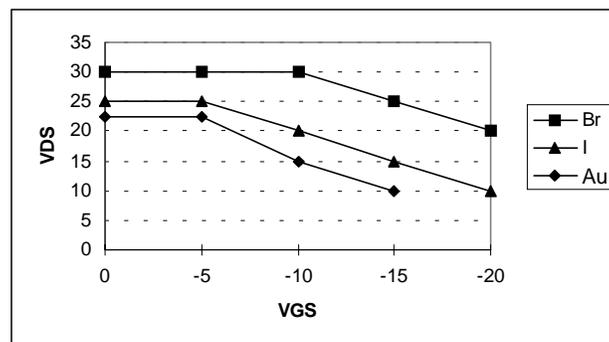
1. Part numbers IRHF57Z30, IRHF53Z30 and IRHF54Z30

2. Part number IRHF58Z30

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)	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

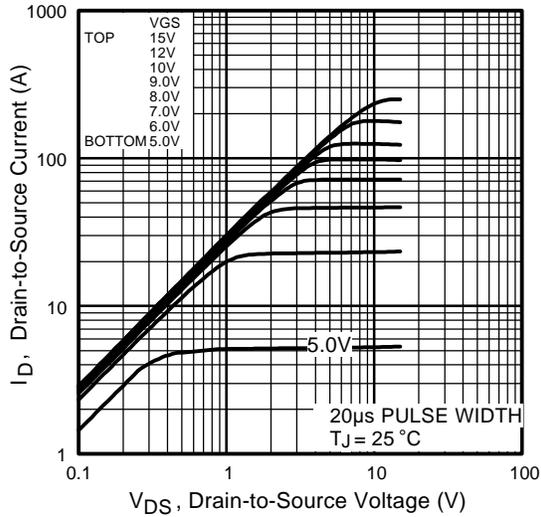


Fig 1. Typical Output Characteristics

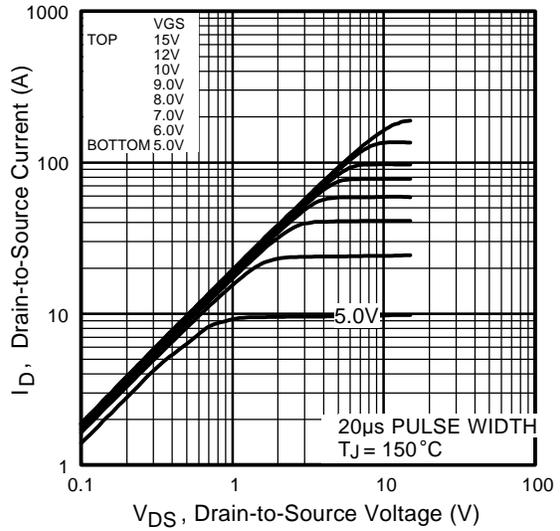


Fig 2. Typical Output Characteristics

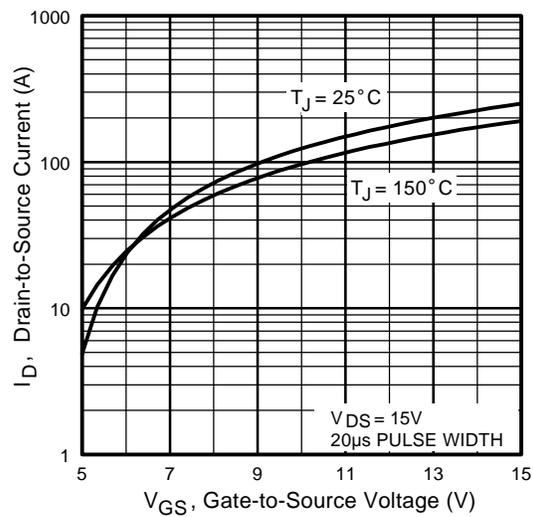


Fig 3. Typical Transfer Characteristics

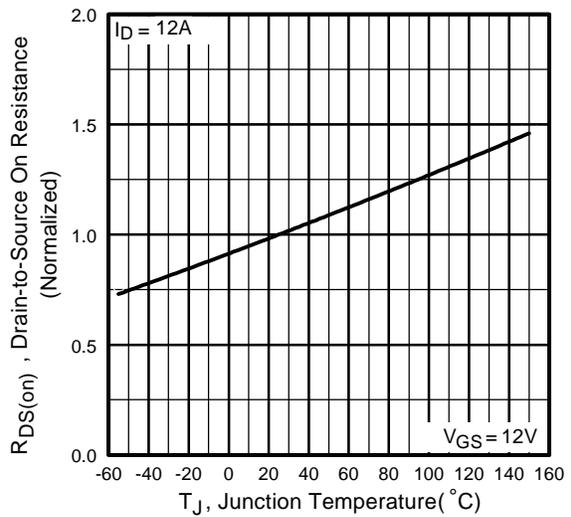


Fig 4. Normalized On-Resistance Vs. Temperature

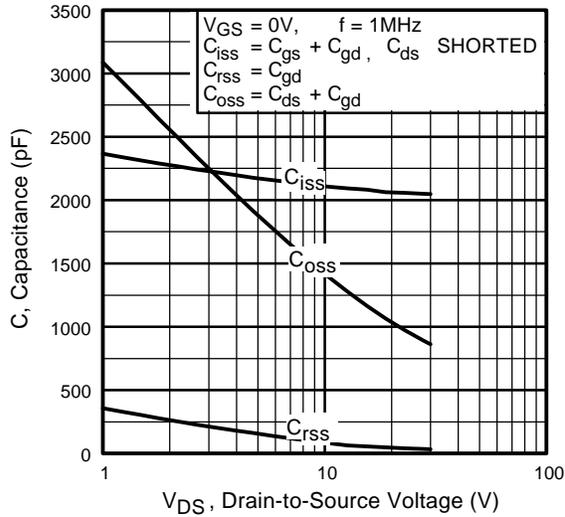


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

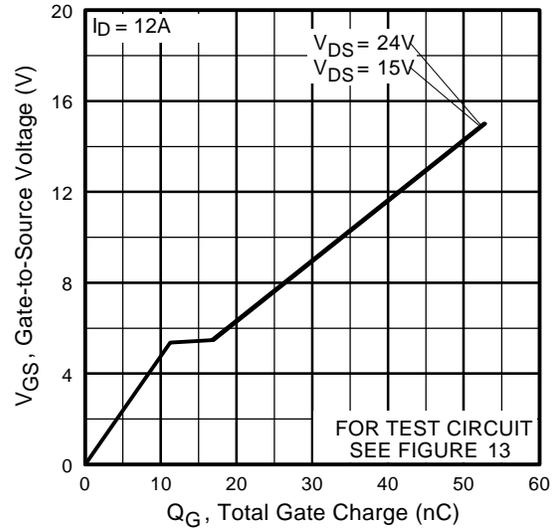


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

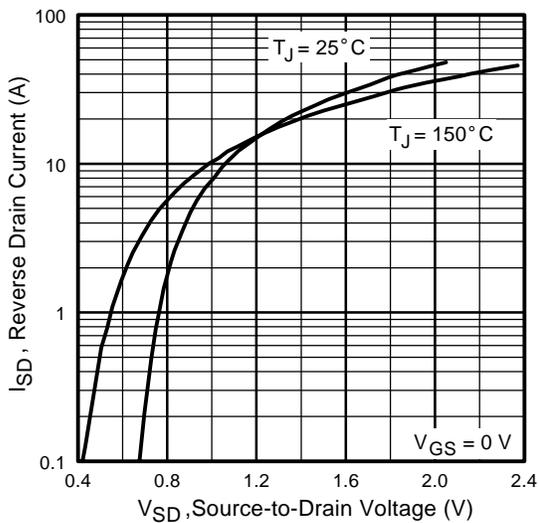


Fig 7. Typical Source-Drain Diode Forward Voltage

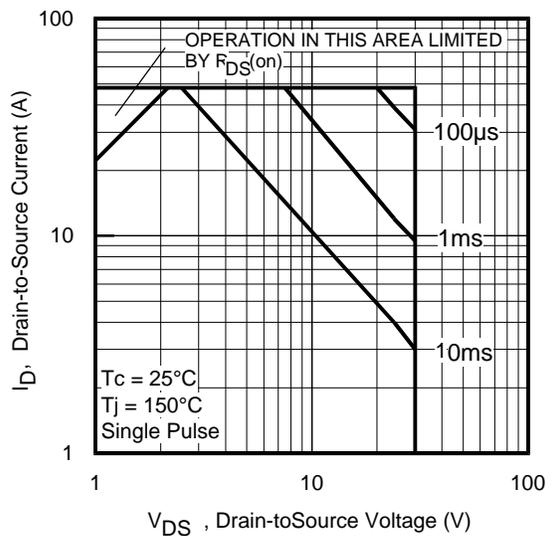


Fig 8. Maximum Safe Operating Area

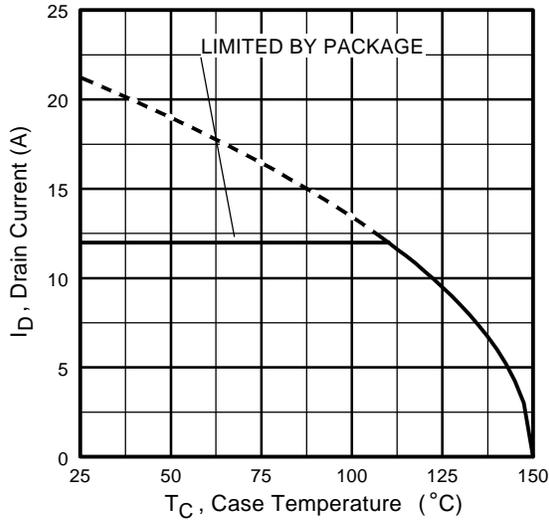


Fig 9. Maximum Drain Current Vs. Case Temperature

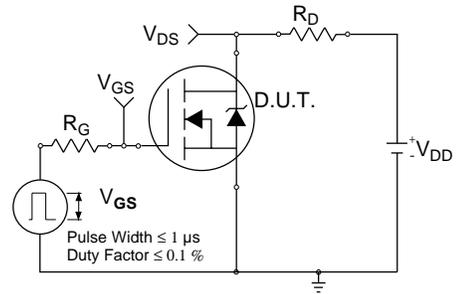


Fig 10a. Switching Time Test Circuit

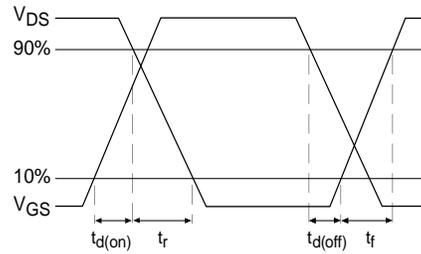


Fig 10b. Switching Time Waveforms

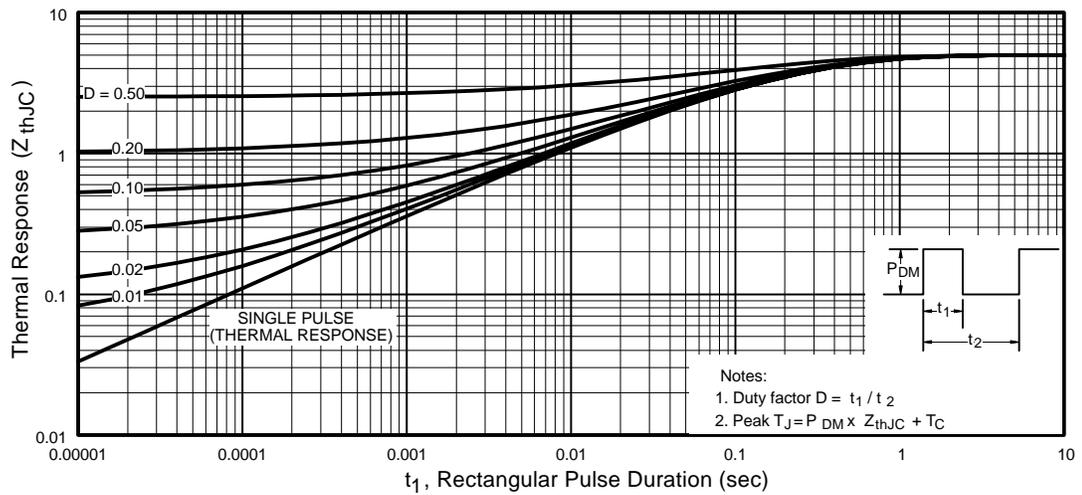


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

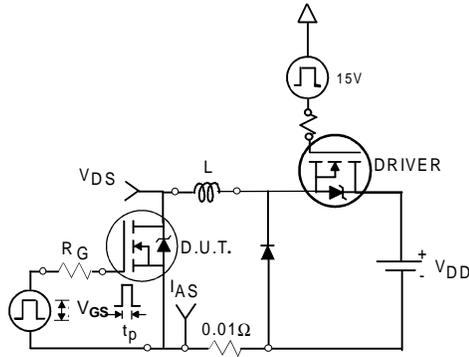


Fig 12a. Unclamped Inductive Test Circuit

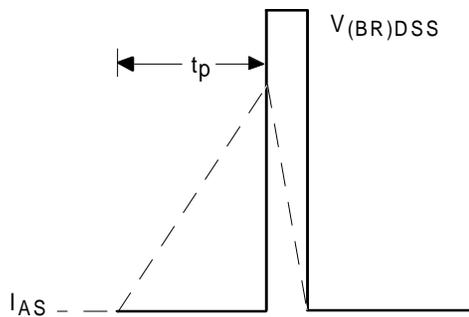


Fig 12b. Unclamped Inductive Waveforms

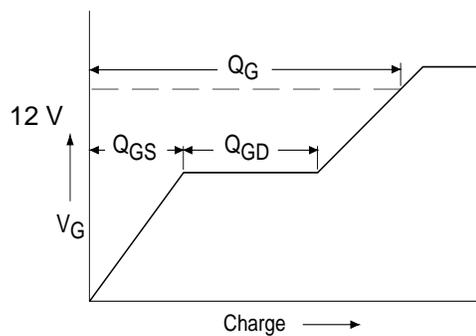


Fig 13a. Basic Gate Charge Waveform

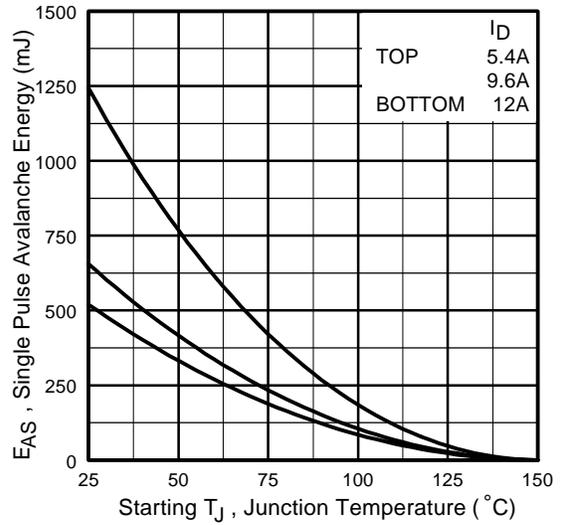


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

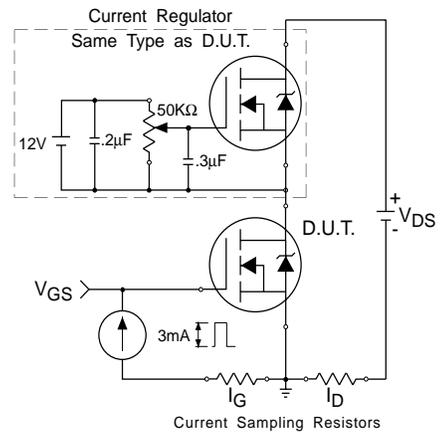
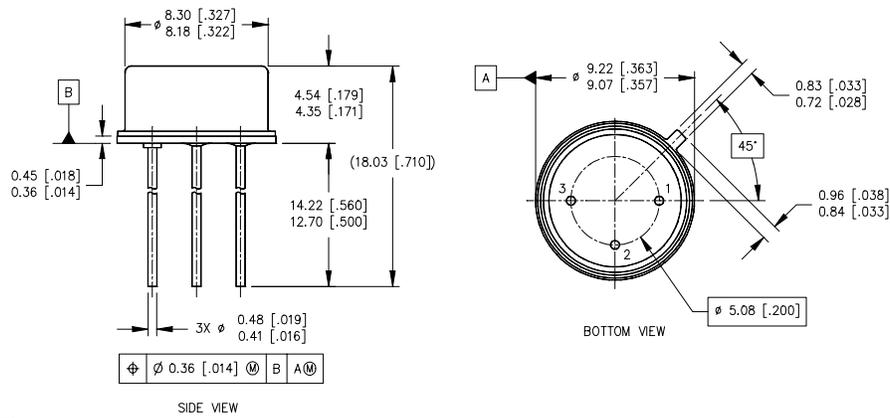


Fig 13b. Gate Charge Test Circuit

**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 20V$ , starting  $T_J = 25^\circ C$ ,  $L = 7.2\text{ mH}$   
Peak  $I_L = 12A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 12A$ ,  $di/dt \leq 135A/\mu s$ ,  
 $V_{DD} \leq 30V$ ,  $T_J \leq 150^\circ C$
- 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.**  
24 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**



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