

## RADIATION HARDENED POWER MOSFET THRU-HOLE (TO-254AA)

**IRHM7460SE**  
**JANSR2N7392 500V**  
**N-CHANNEL**  
**REF: MIL-PRF-19500/661**

**RAD Hard™ HEXFET® TECHNOLOGY**

### Product Summary

Part Number	Radiation Level	RDS(on)	ID	QPL Part Number
IRHM7460SE	100K Rads (Si)	0.32Ω	18A	JANSR2N7392



International Rectifier's RADHard™ HEXFET® MOSFET technology provides high performance power MOSFETs for space applications. This technology has over a decade of proven performance and reliability in satellite applications. These devices have been characterized for both Total Dose and Single Event Effects (SEE). 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)
- Low Total Gate Charge
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Light Weight

### Absolute Maximum Ratings

### Pre-Irradiation

	Parameter		Units
ID @ VGS = 12V, TC = 25°C	Continuous Drain Current	18	A
ID @ VGS = 12V, TC = 100°C	Continuous Drain Current	11.7	
IDM	Pulsed Drain Current ①	72	
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 ②	500	mJ
IAR	Avalanche Current ①	18	A
EAR	Repetitive Avalanche Energy ①	25	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.8	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10 sec.)	
	Weight	9.3 (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	500	—	—	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	—	0.66	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.32	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 11.7A ④
		—	—	0.36		V <sub>GS</sub> = 12V, I <sub>D</sub> = 18A
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.5	—	4.5	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1.0mA
g <sub>fs</sub>	Forward Transconductance	6.0	—	—	S (r)	V <sub>DS</sub> > 15V, I <sub>DS</sub> = 11.7A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	50	μA	V <sub>DS</sub> = 400V, V <sub>GS</sub> = 0V
		—	—	250		V <sub>DS</sub> = 400V, 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	—	—	180	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 18A V <sub>DS</sub> = 250V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	30		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	95		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	29	ns	V <sub>DD</sub> = 250V, I <sub>D</sub> = 18A, V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω
t <sub>r</sub>	Rise Time	—	—	93		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	90		
t <sub>f</sub>	Fall Time	—	—	59		
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	—	3500	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	730	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	260	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	18	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	72		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.8	V	T <sub>j</sub> = 25°C, I <sub>S</sub> = 18A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	800	nS	T <sub>j</sub> = 25°C, I <sub>F</sub> = 18A, di/dt ≤ 100A/μs V <sub>DD</sub> ≤ 50V ④
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	16	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	—	—	0.50	°C/W	Typical socket mount
R <sub>thCS</sub>	Case-to-Sink	—	0.21	—		
R <sub>thJA</sub>	Junction-to-Ambient	—	—	48		

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

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-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.

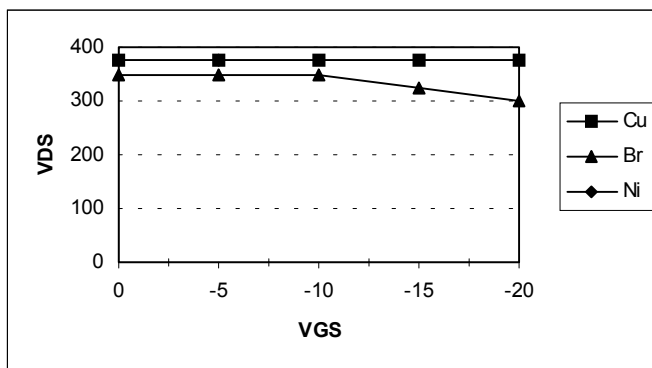
**Table 1. Electrical Characteristics @  $T_j = 25^\circ\text{C}$ , Post Total Dose Irradiation ⑤⑥**

	Parameter	100K Rads (Si)		Units	Test Conditions ⑧
		Min	Max		
$BV_{DSS}$	Drain-to-Source Breakdown Voltage	500	—	V	$V_{GS} = 0V, I_D = 1.0mA$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.5		$V_{GS} = V_{DS}, I_D = 1.0mA$
$I_{GSS}$	Gate-to-Source Leakage Forward	—	100	nA	$V_{GS} = 20V$
$I_{GSS}$	Gate-to-Source Leakage Reverse	—	-100		$V_{GS} = -20V$
$I_{DSS}$	Zero Gate Voltage Drain Current	—	50	$\mu A$	$V_{DS} = 400V, V_{GS} = 0V$
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.32	$\Omega$	$V_{GS} = 12V, I_D = 11.7A$
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-254)	—	0.32	$\Omega$	$V_{GS} = 12V, I_D = 11.7A$
$V_{SD}$	Diode Forward Voltage ④	—	1.8	V	$V_{GS} = 0V, I_D = 18A$

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 ( $\mu m$ )	$V_{DS}$ (V)				
				@ $V_{GS}=0V$	@ $V_{GS}=5V$	@ $V_{GS}=10V$	@ $V_{GS}=15V$	@ $V_{GS}=20V$
Cu	28	285	43	375	375	375	375	375
Br	36.8	305	39	350	350	350	325	300
Ni	26.6	265	42	—	375	—	—	—



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

For footnotes refer to the last page

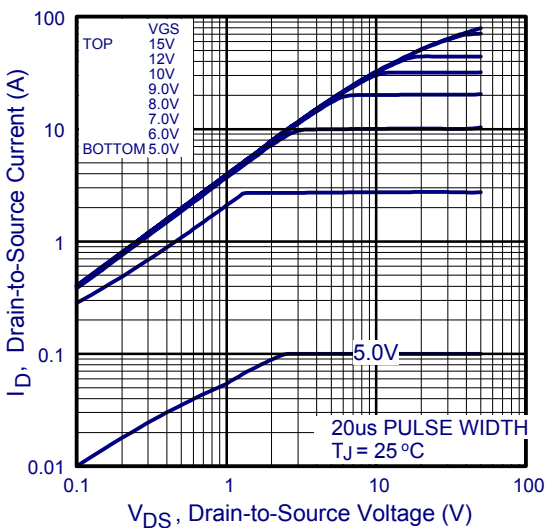


Fig 1. Typical Output Characteristics

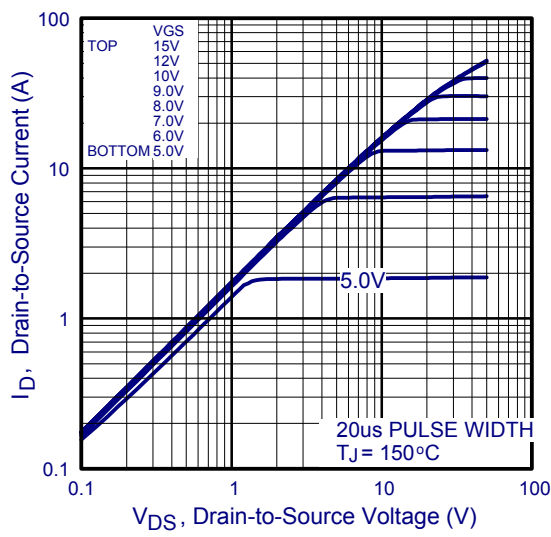


Fig 2. Typical Output Characteristics

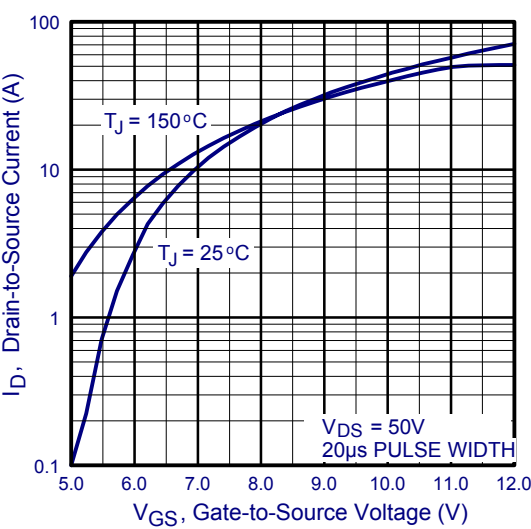


Fig 3. Typical Transfer Characteristics

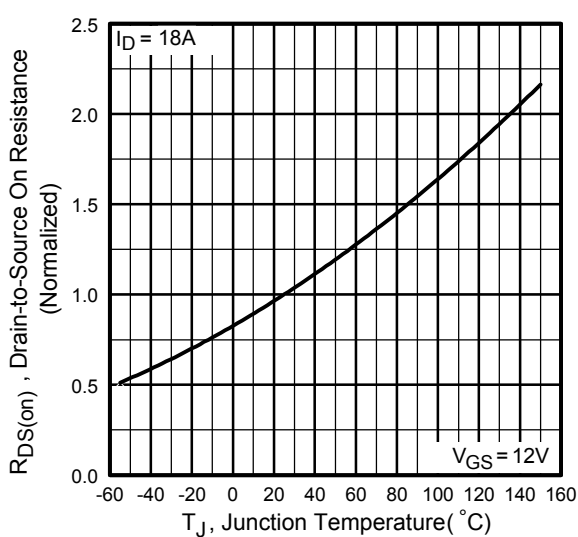
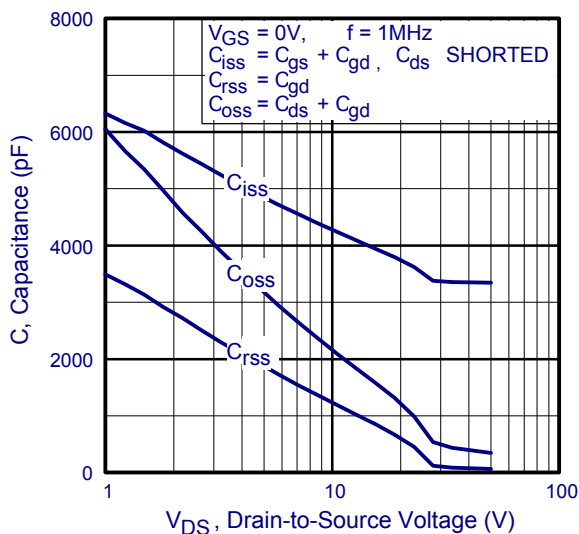
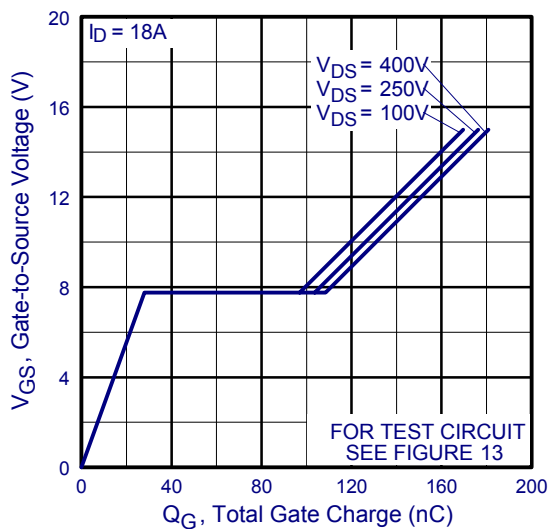


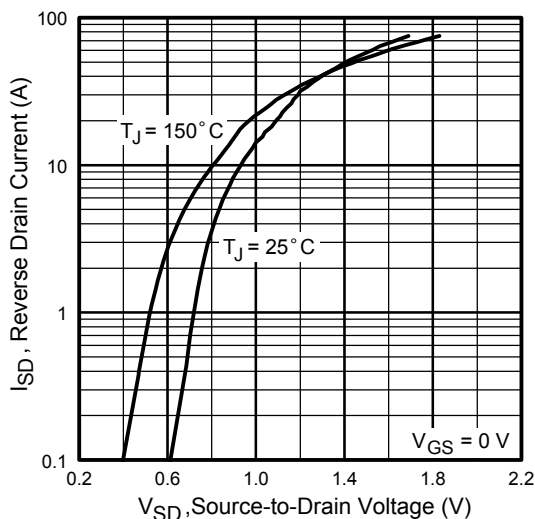
Fig 4. Normalized On-Resistance Vs. Temperature



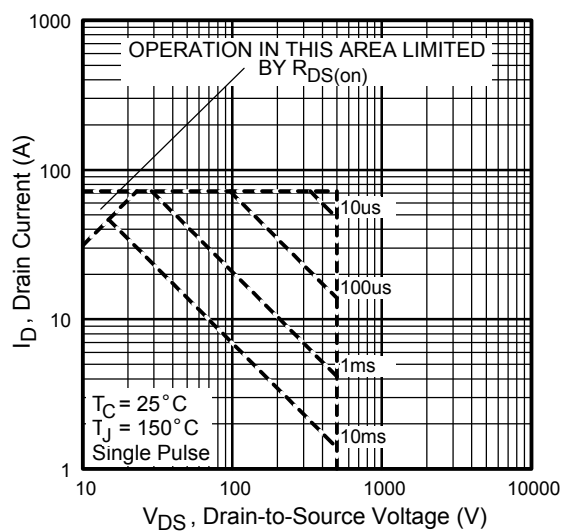
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



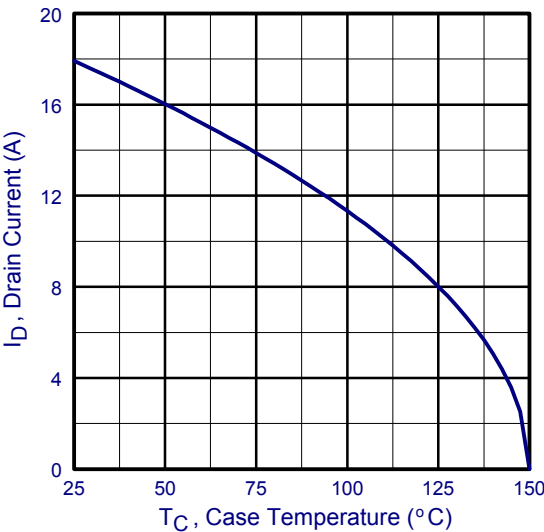
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



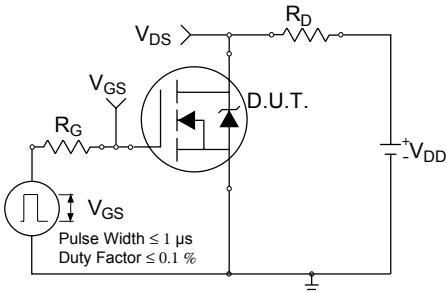
**Fig 7.** Typical Source-Drain Diode Forward Voltage



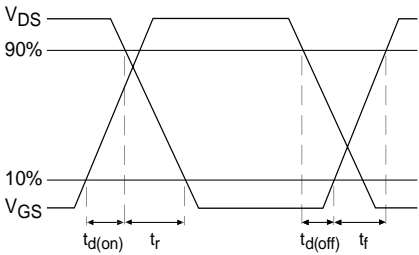
**Fig 8.** Maximum Safe Operating Area



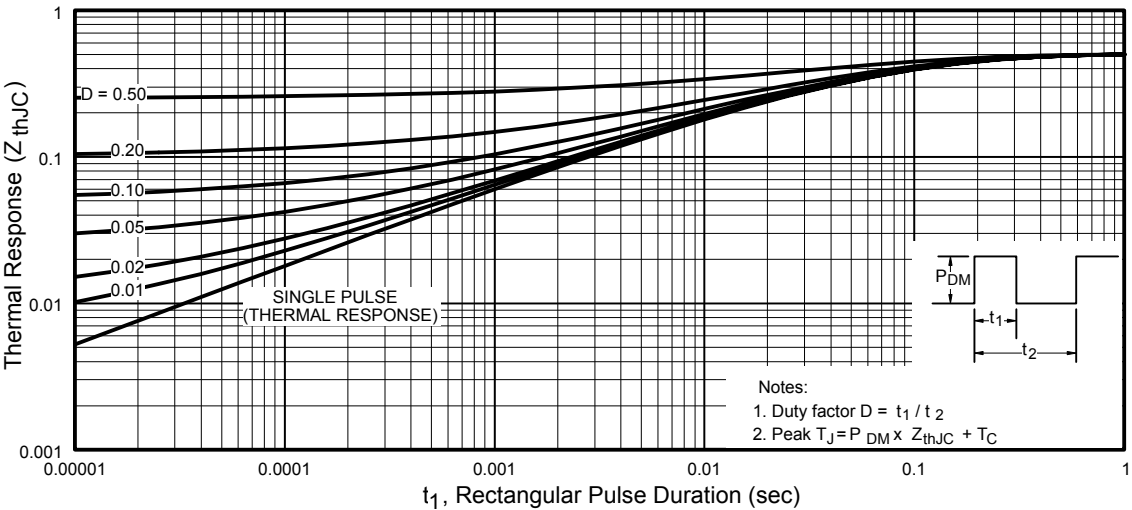
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



**Fig 10b.** Switching Time Waveforms



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

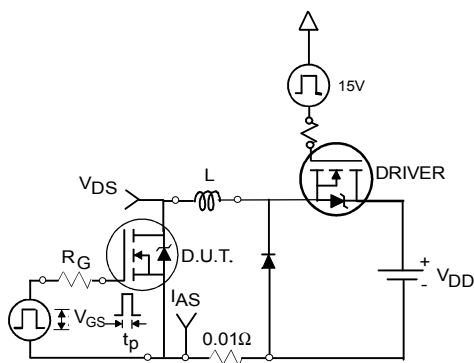


Fig 12a. Unclamped Inductive Test Circuit

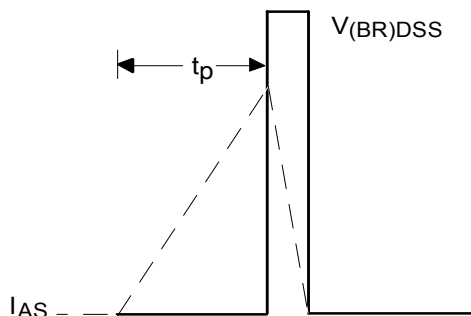


Fig 12b. Unclamped Inductive Waveforms

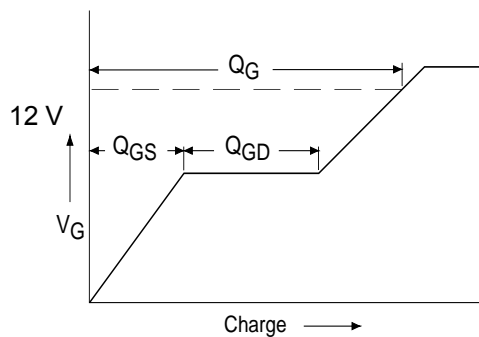


Fig 13a. Basic Gate Charge Waveform

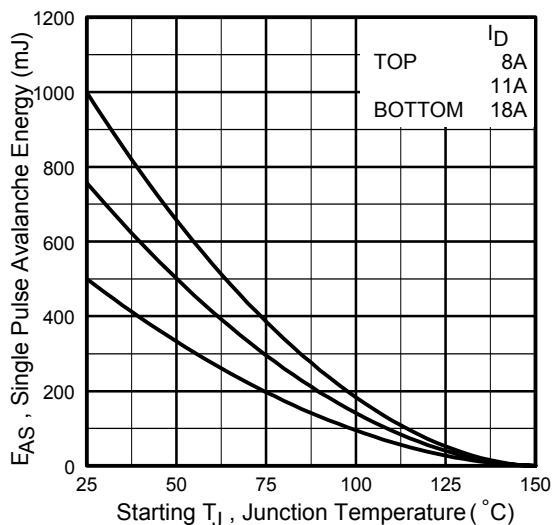


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

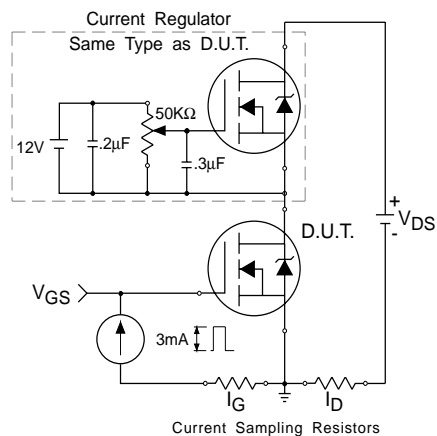
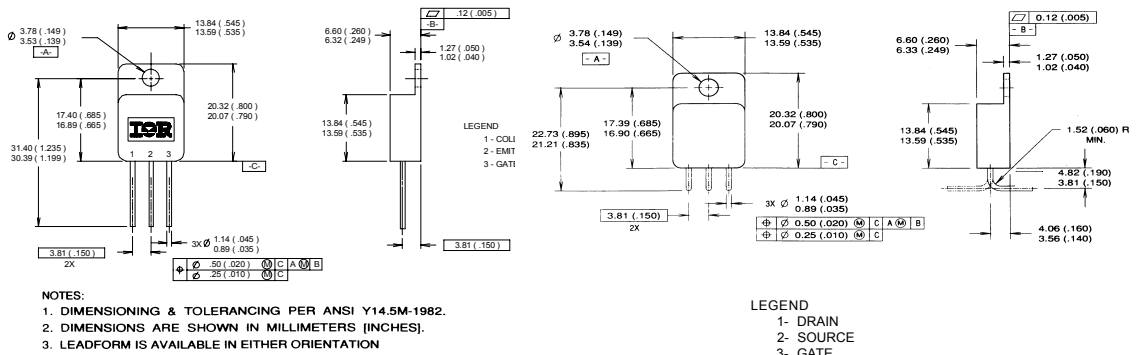


Fig 13b. Gate Charge Test Circuit

## Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 50V$ , starting  $T_J = 25^\circ C$ ,  $L = 3.1\text{ mH}$   
Peak  $I_L = 18A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 18A$ ,  $di/dt \leq 110A/\mu s$ ,  
 $V_{DD} \leq 500V$ ,  $T_J \leq 150^\circ C$
- ④ Pulse width  $\leq 300\text{ }\mu s$ ; 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.**  
400 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

## Case Outline and Dimensions —TO-254AA



## CAUTION

## BERYLLIA WARNING PER MIL-PRF-19500

Package containing beryllia shall not be ground, sandblasted, machined, or have other operations performed on them which will produce beryllia or beryllium dust. Furthermore, beryllium oxide packages shall not be placed in acids that will produce fumes containing beryllium.

International  
**IR Rectifier**

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