

International  
**IR** Rectifier  
**RADIATION HARDENED  
 POWER MOSFET  
 SURFACE MOUNT(SMD-2)**

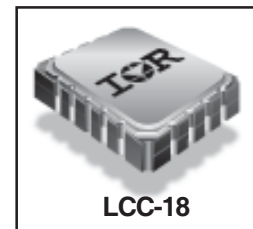
PD - 94325A

**IRHE57133SE  
 JANSR2N7500U5  
 130V, N-CHANNEL  
 REF: MIL-PRF-19500/707**



**Product Summary**

Part Number	Radiation Level	$R_{DS(on)}$	$I_D$	QPL Part Number
IRHE57133SE	100K Rads (Si)	0.13 $\Omega$	9.0A	JANSR2N7500U5



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  $R_{DS(on)}$  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  $R_{DS(on)}$
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Surface Mount
- Ceramic Package
- Light Weight

**Absolute Maximum Ratings**

**Pre-Irradiation**

	Parameter		Units
$I_D$ @ $V_{GS} = 12V, T_C = 25^\circ C$	Continuous Drain Current	9.0	A
$I_D$ @ $V_{GS} = 12V, T_C = 100^\circ C$	Continuous Drain Current	6.0	
$I_{DM}$	Pulsed Drain Current ①	36	
$P_D$ @ $T_C = 25^\circ C$	Max. Power Dissipation	25	W
	Linear Derating Factor	0.2	W/°C
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
EAS	Single Pulse Avalanche Energy ②	56	mJ
IAR	Avalanche Current ①	9.0	A
EAR	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	6.6	V/ns
$T_J$	Operating Junction	-55 to 150	°C
$T_{STG}$	Storage Temperature Range		
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	0.42 (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	130	—	—	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	—	0.16	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.13	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.0A ④
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	5.0	—	—	S (r̄)	V <sub>DS</sub> ≥ 15V, I <sub>DS</sub> = 6.0A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	10	μA	V <sub>DS</sub> = 104V, V <sub>GS</sub> = 0V
		—	—	25		V <sub>DS</sub> = 104V, 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	—	—	48	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 9.0A V <sub>DS</sub> = 65V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	16		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	18		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	25	ns	V <sub>DD</sub> = 65V, I <sub>D</sub> = 9.0A, V <sub>GS</sub> = 12V, R <sub>G</sub> = 7.5Ω
t <sub>r</sub>	Rise Time	—	—	100		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	35		
t <sub>f</sub>	Fall Time	—	—	40		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	6.1	—	nH	Measured from the center of drain pad to center of source pad
C <sub>iss</sub>	Input Capacitance	—	1020	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	306	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	22	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	9.0	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	36		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.5	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = 9.0A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	250	nS	T <sub>J</sub> = 25°C, I <sub>F</sub> = 9.0A, di/dt ≤ 100A/μs
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	1.5	μC	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 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	soldered to a copper-clad PC board
R <sub>thJ-PCB</sub>	Junction-to-PC board	—	19	—		

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

For footnotes refer to the last page

## Radiation Characteristics

## IRHE57133SE, JANSR2N7500U5

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.

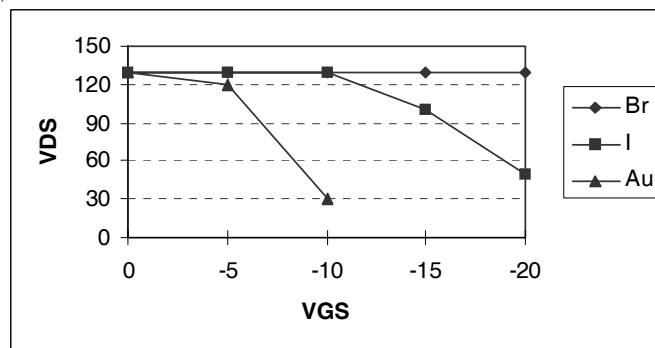
**Table 1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation ⑤⑥**

	Parameter	100K Rads (Si)		Units	Test Conditions ③
		Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	130	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	4.5		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	—	10	μA	V <sub>DS</sub> =104V, V <sub>GS</sub> =0V
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.111	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.0A
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (LCC-18)	—	0.13	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.0A
V <sub>SD</sub>	Diode Forward Voltage ④	—	1.5	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 9.0A

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	36.7	309	39.5	130	130	130	130	130
I	59.8	341	32.5	130	130	130	100	50
Au	82.3	350	28.4	130	120	30	—	—



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

For footnotes refer to the last page

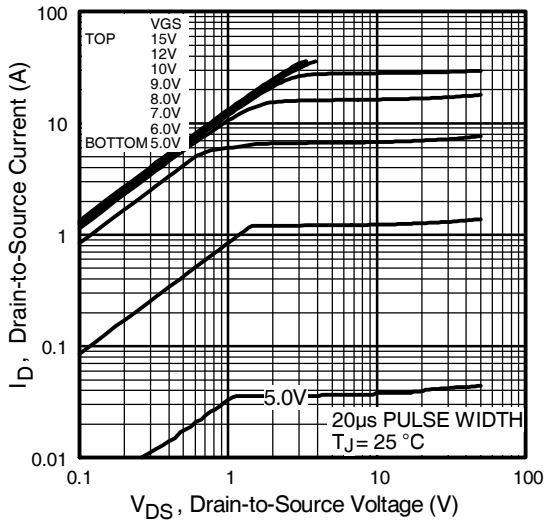


Fig 1. Typical Output Characteristics

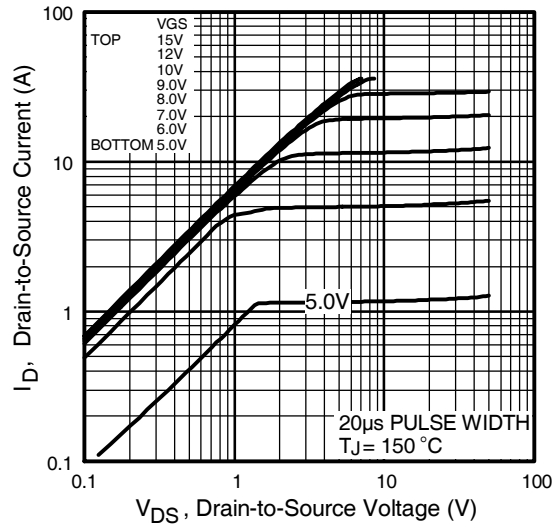


Fig 2. Typical Output Characteristics

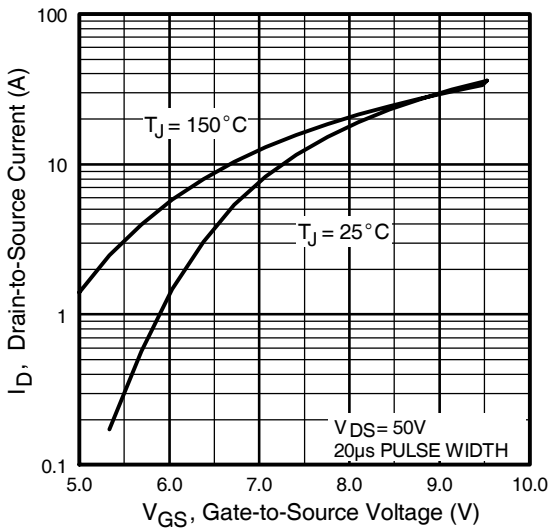


Fig 3. Typical Transfer Characteristics

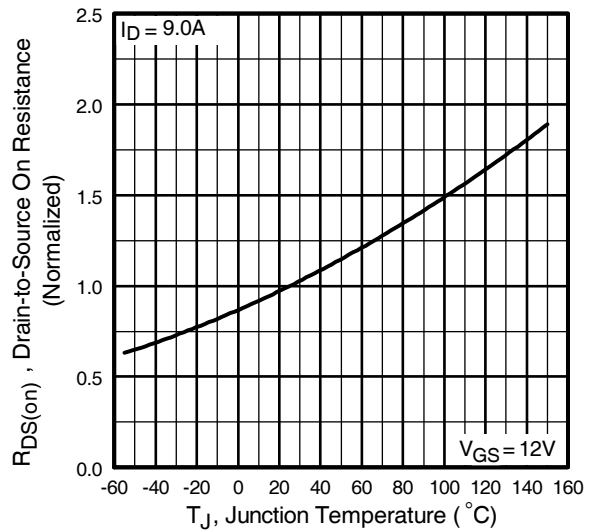


Fig 4. Normalized On-Resistance Vs. Temperature

Pre-Irradiation

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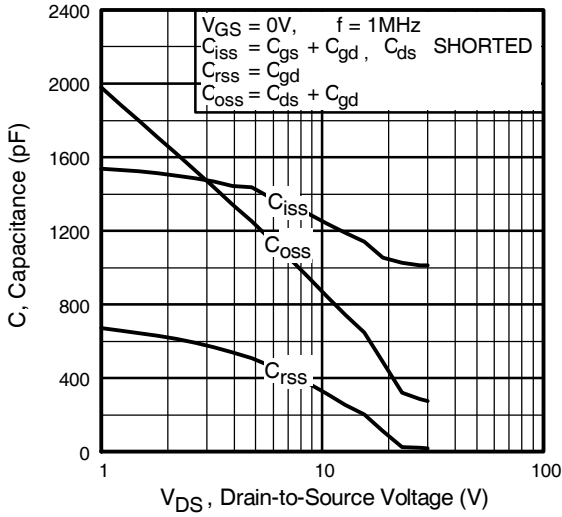


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

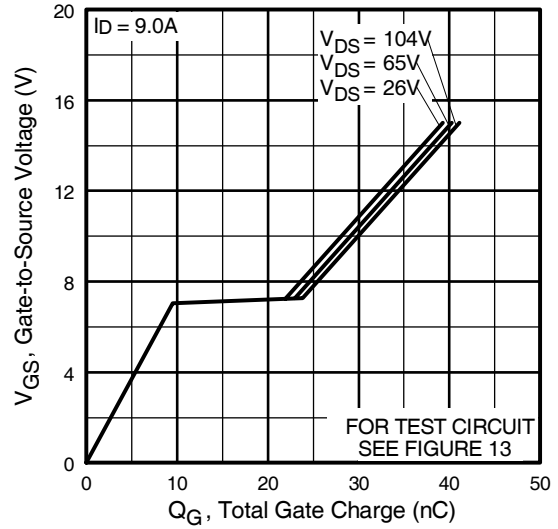


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

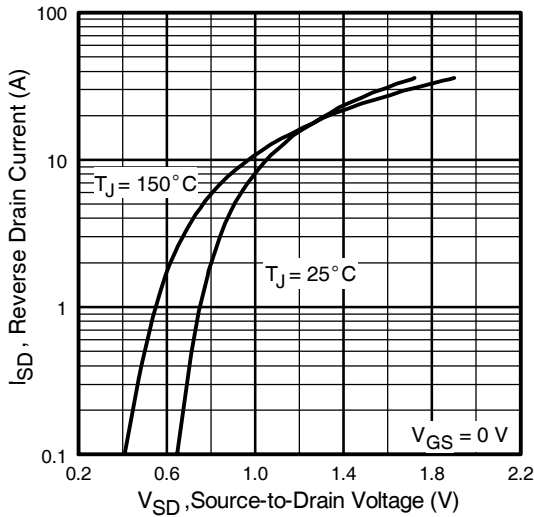


Fig 7. Typical Source-Drain Diode Forward Voltage

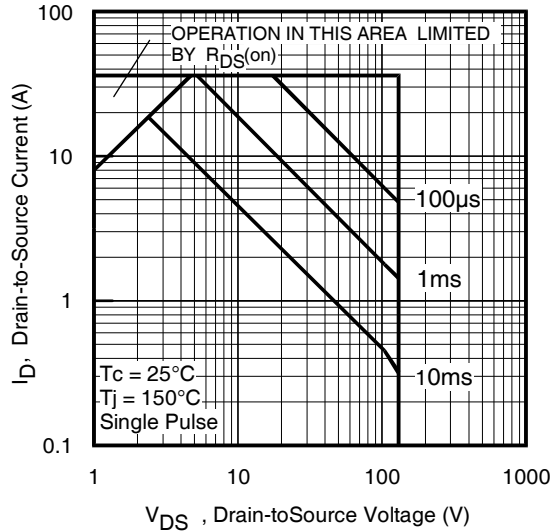


Fig 8. Maximum Safe Operating Area

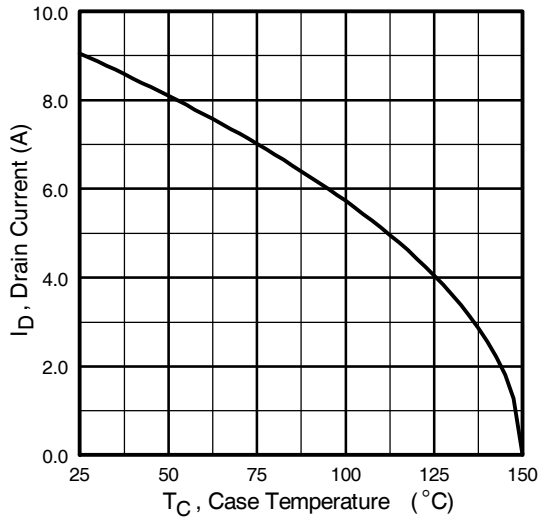


Fig 9. Maximum Drain Current Vs. Case Temperature

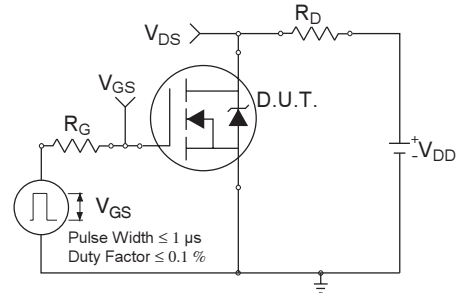


Fig 10a. Switching Time Test Circuit



Fig 10b. Switching Time Waveforms

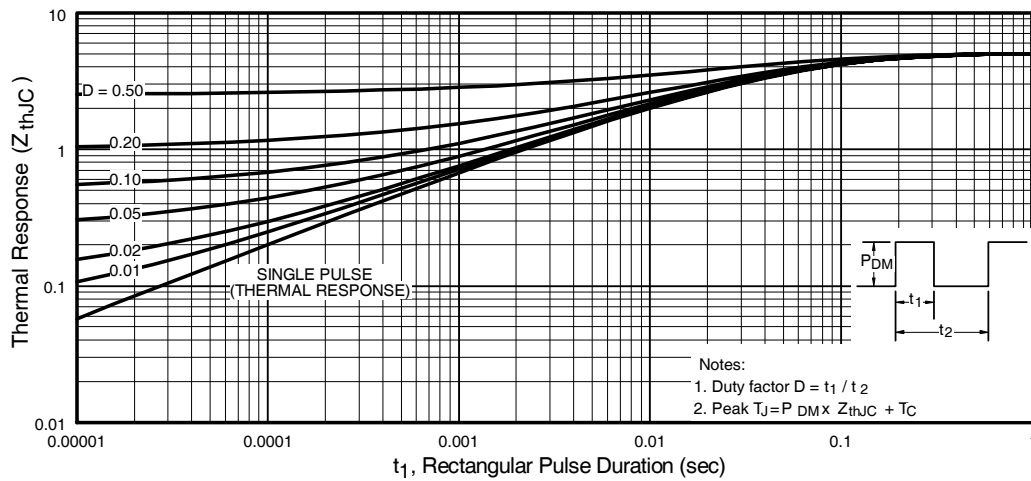
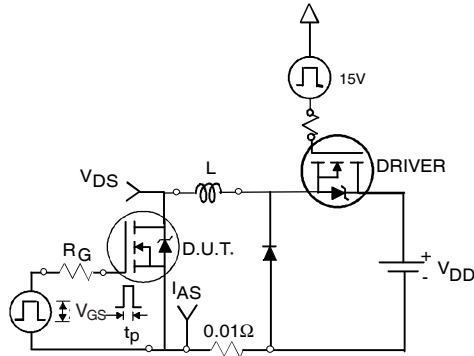


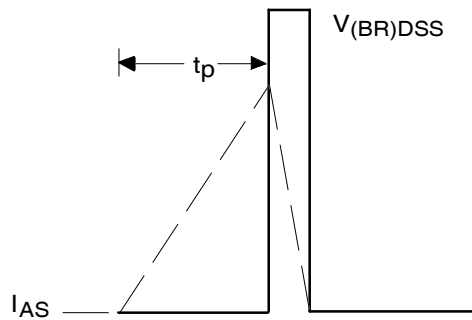
Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

**Pre-Irradiation**

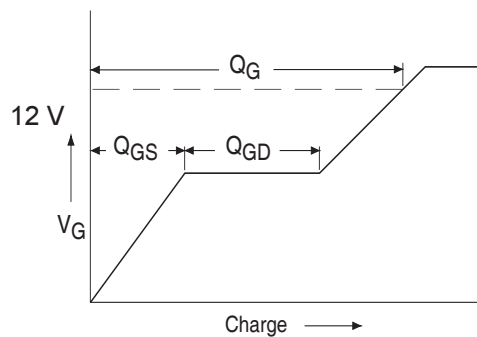
**IRHE57133SE, JANSR2N7500U5**



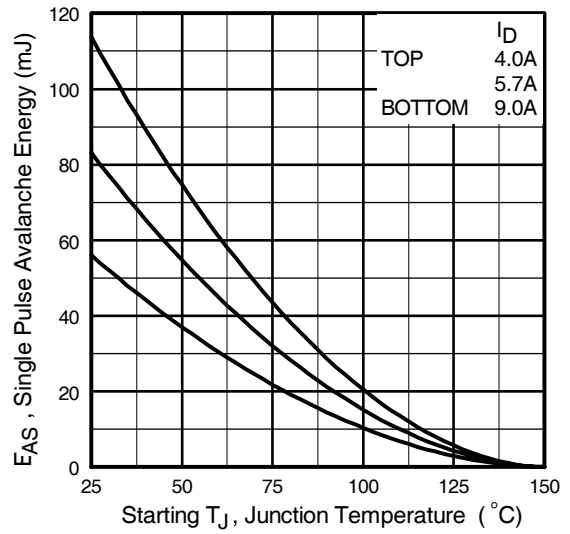
**Fig 12a.** Unclamped Inductive Test Circuit



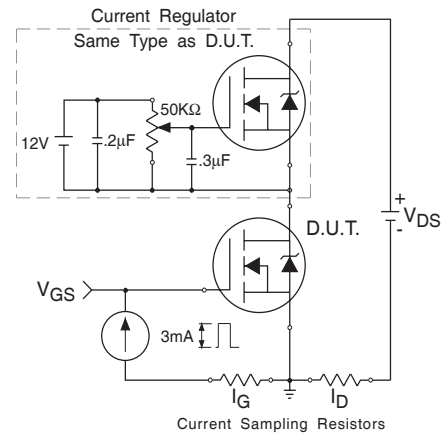
**Fig 12b.** Unclamped Inductive Waveforms



**Fig 13a.** Basic Gate Charge Waveform



**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

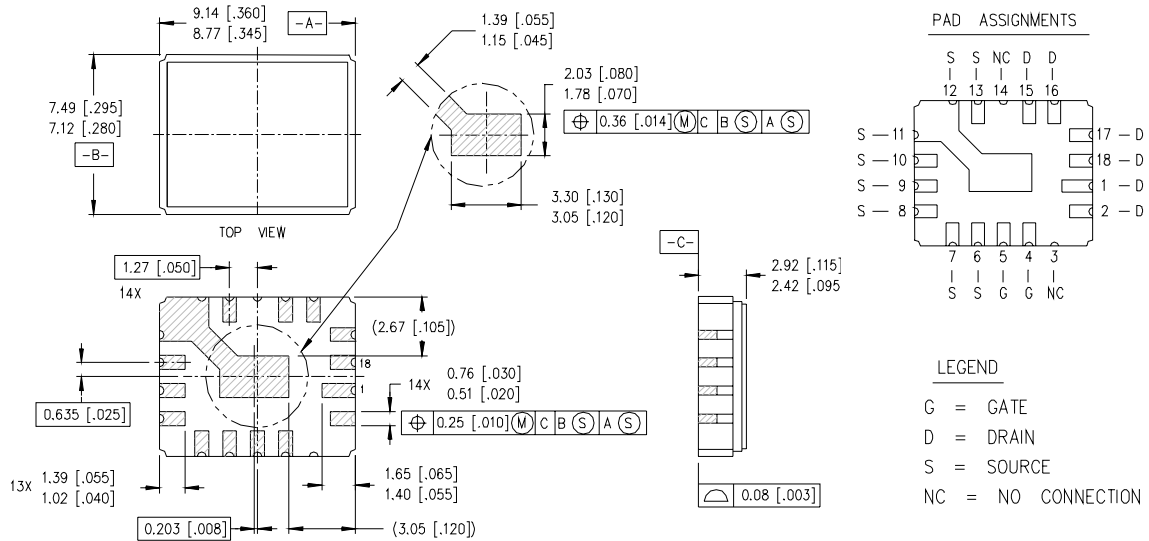


**Fig 13b.** Gate Charge Test Circuit

**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 50V$ , starting  $T_J = 25^\circ C$ ,  $L=1.4mH$   
Peak  $I_L = 9.0A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 9.0A$ ,  $di/dt \leq 270A/\mu s$ ,  
 $V_{DD} \leq 130V$ ,  $T_J \leq 150^\circ C$
- 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.**  
104 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Case Outline and Dimensions — LCC-18**



- NOTES:
- DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982.
  - CONTROLLING DIMENSION: INCH.
  - DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].



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