

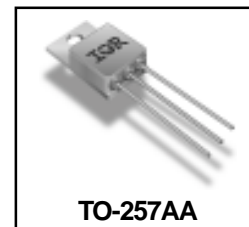
International  
**IR** Rectifier  
**RADIATION HARDENED  
 POWER MOSFET  
 THRU-HOLE (TO-257AA)**

PD - 91273C

**IRHY7230CM  
 JANSR2N7381  
 200V, N-CHANNEL  
 REF:MIL-PRF-19500/614  
 RAD-Hard™ HEXFET® TECHNOLOGY**

**Product Summary**

Part Number	Radiation Level	R <sub>DS(on)</sub>	I <sub>D</sub>	QPL Part Number
IRHY7230CM	100K Rads (Si)	0.40Ω	9.4A	JANSR2N7381
IRHY3230CM	300K Rads (Si)	0.40Ω	9.4A	JANSF227381
IRHY4230CM	600K Rads (Si)	0.40Ω	9.4A	JANSG2N7381
IRHY8230CM	1000K Rads (Si)	0.40Ω	9.4A	JANSH2N7381



International Rectifier's RADHard HEXFET® 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 R<sub>ds(on)</sub> 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
- Low R<sub>DS(on)</sub>
- Low Total Gate Charge
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Eyelets
- 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	9.4	A
I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 100°C	Continuous Drain Current	6.0	
I <sub>DM</sub>	Pulsed Drain Current ①	37	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Max. Power Dissipation	75	W
	Linear Derating Factor	0.6	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	150	mJ
I <sub>AR</sub>	Avalanche Current ①	5.5	A
E <sub>AR</sub>	Repetitive Avalanche Energy ①	7.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	16	V/ns
T <sub>J</sub>	Operating Junction	-55 to 150	°C
T <sub>STG</sub>	Storage Temperature Range		
	Lead Temperature	300 ( 0.063 in.(1.6mm) from case for 10s)	
	Weight	7.0 (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
B <sub>V</sub> DSS	Drain-to-Source Breakdown Voltage	200	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔB <sub>V</sub> DSS/ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.23	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.40	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.0A ④
		—	—	0.49		V <sub>GS</sub> = 12V, I <sub>D</sub> = 9.4A
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	2.5	—	—	S (Ω)	V <sub>DS</sub> > 15V, I <sub>DS</sub> = 6.0A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	25	μA	V <sub>DS</sub> = 160V, V <sub>GS</sub> = 0V
		—	—	250		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	nA	V <sub>GS</sub> = -20V
Q <sub>g</sub>	Total Gate Charge	—	—	50	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 9.4A V <sub>DS</sub> = 100V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	10		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	25		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	35	ns	V <sub>DD</sub> = 100V, I <sub>D</sub> = 9.4A V <sub>GS</sub> = 12V, R <sub>G</sub> = 7.5Ω
t <sub>r</sub>	Rise Time	—	—	75		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	70		
t <sub>f</sub>	Fall Time	—	—	60		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	7.0	—	nH	Measured from drain lead (6mm/0.25in. from package) to source lead (6mm/0.25in. from package)
C <sub>iss</sub>	Input Capacitance	—	1200	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	250	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	63	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	9.4	A	T <sub>J</sub> = 25°C, I <sub>S</sub> = 9.4A, V <sub>GS</sub> = 0V ④
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	37		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.4	V	T <sub>J</sub> = 25°C, I <sub>F</sub> = 9.4A, di/dt ≤ 100A/μs
t <sub>rr</sub>	Reverse Recovery Time	—	—	460	nS	V <sub>DD</sub> ≤ 50V ④
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	2.4	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	—	—	1.67	°C/W	Typical socket mount
R <sub>thJA</sub>	Junction-to-Ambient	—	—	80		

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

For footnotes refer to the last page

## Radiation Characteristics

## IRHY7230CM

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	100 KRads(Si) <sup>1</sup>		300 - 1000K Rads (Si) <sup>2</sup>		Units	Test Conditions
		Min	Max	Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	200	—	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	1.25	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	—	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	—	25	—	25	μA	V <sub>DS</sub> =160V, V <sub>GS</sub> =0V
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.40	—	0.53	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 (TO-257AA)	—	0.40	—	0.53	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> =6.0A
V <sub>SD</sub>	Diode Forward Voltage ④	—	1.4	—	1.4	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 9.4A

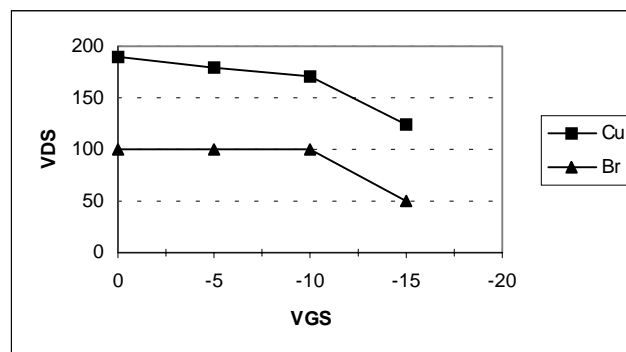
1. Part number IRHY7230CM (JANSR2N7381)

2. Part numbers IRHY3230CM, IRHY4230CM, and IRHY8230CM (JANSF2N7381, JANS2N7381 and JANSH2N7381)

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
Cu	28	285	43	190	180	170	125	—
Br	36.8	305	39	100	100	100	50	—



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

For footnotes refer to the last page

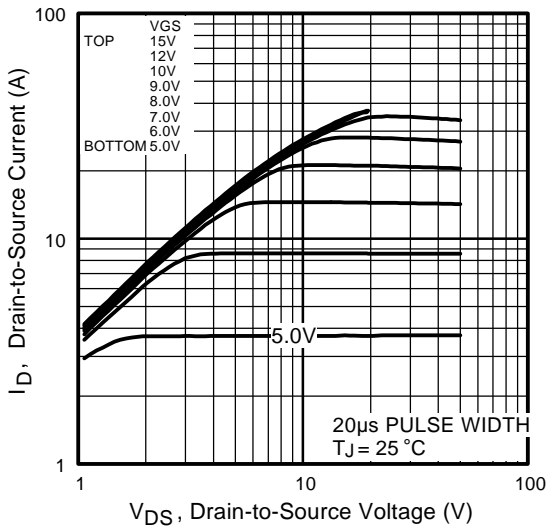


Fig 1. Typical Output Characteristics

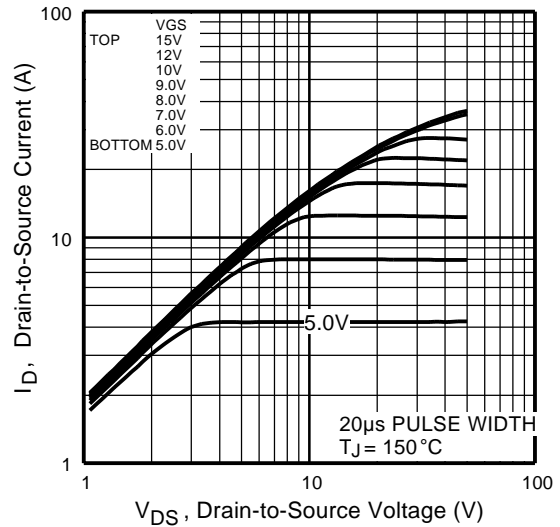


Fig 2. Typical Output Characteristics

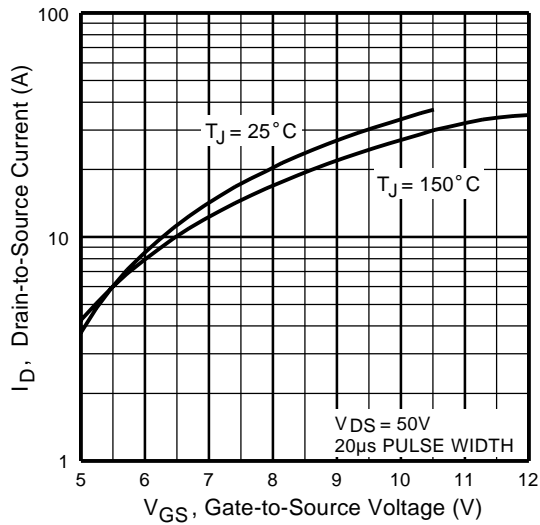


Fig 3. Typical Transfer Characteristics

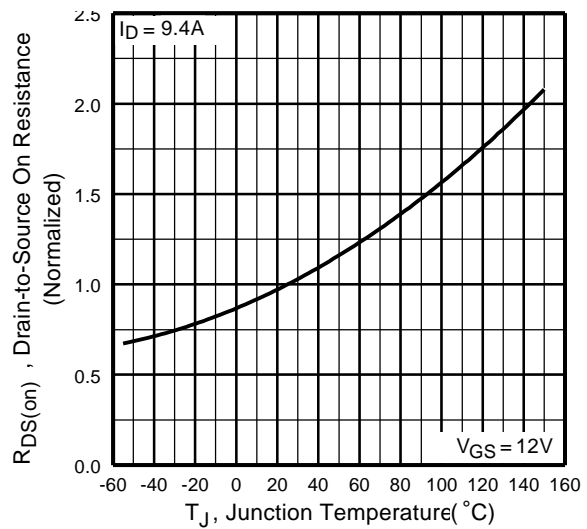
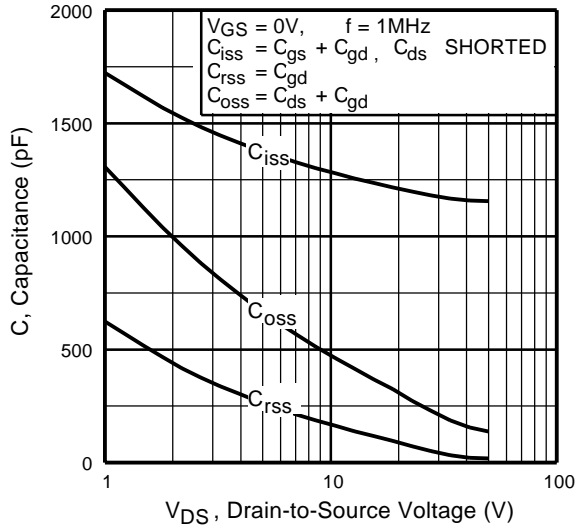
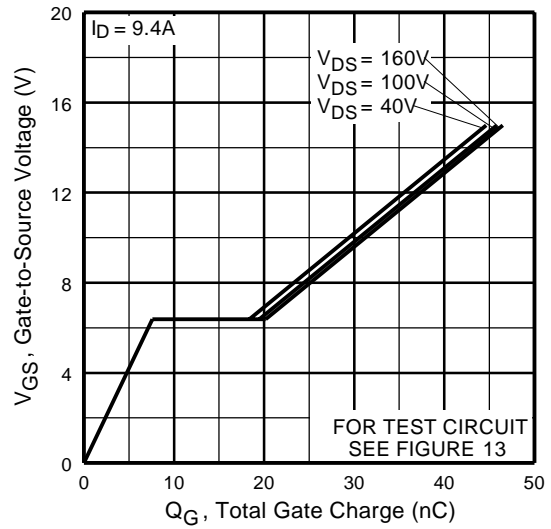


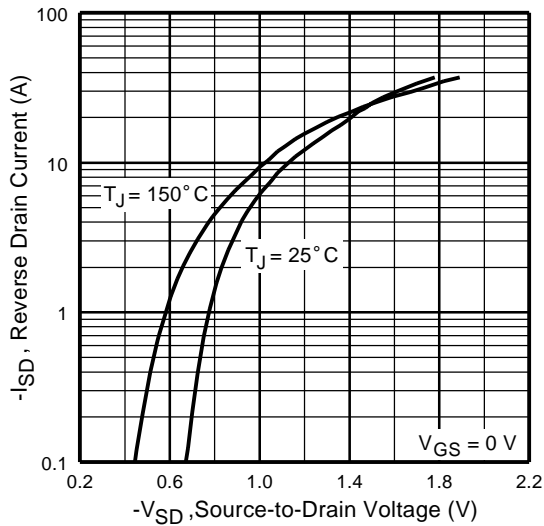
Fig 4. Normalized On-Resistance Vs. Temperature



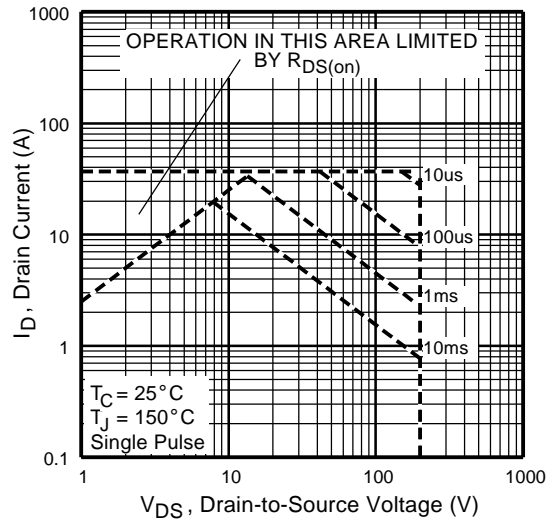
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



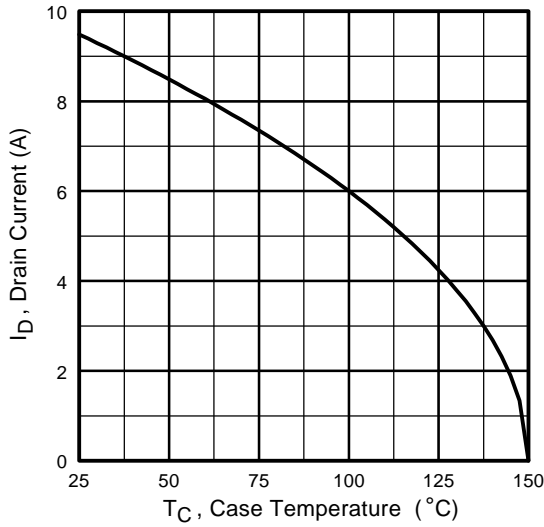
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



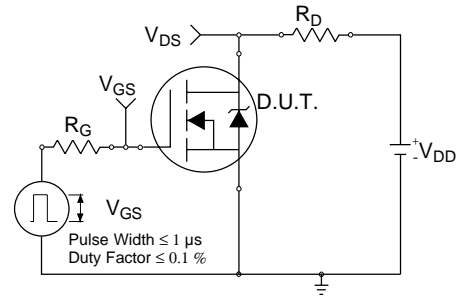
**Fig 7.** Typical Source-Drain Diode Forward Voltage



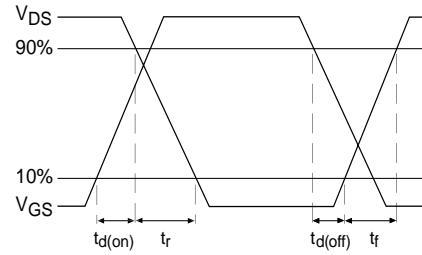
**Fig 8.** Maximum Safe Operating Area



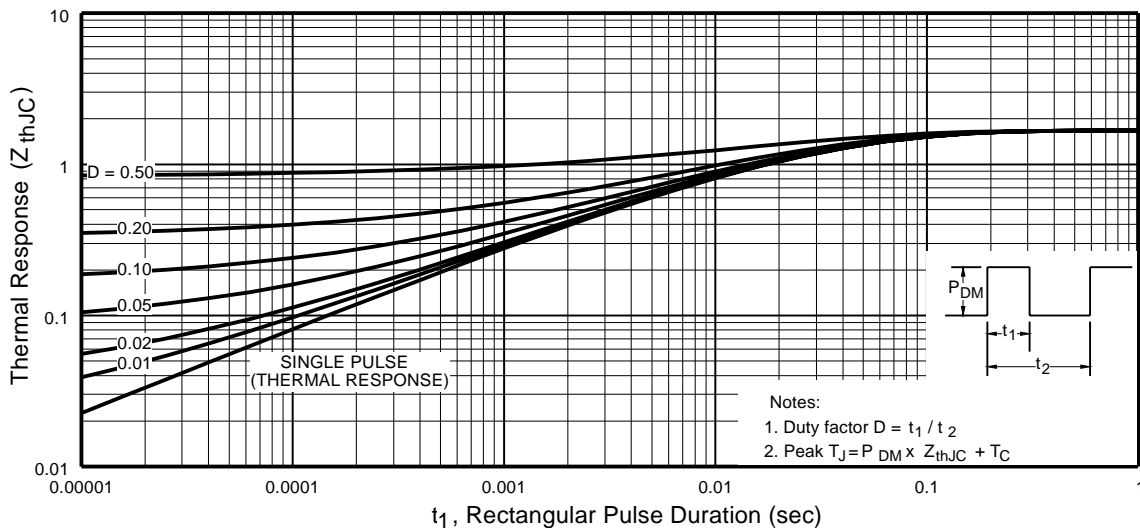
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



**Fig 10b.** Switching Time Waveforms



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

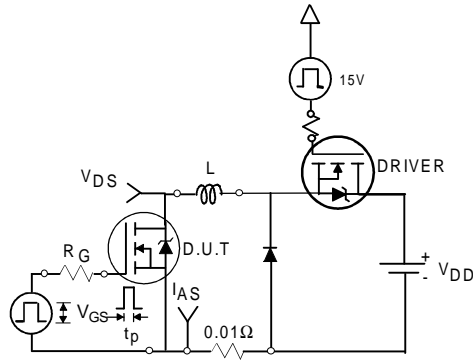


Fig 12a. Unclamped Inductive Test Circuit

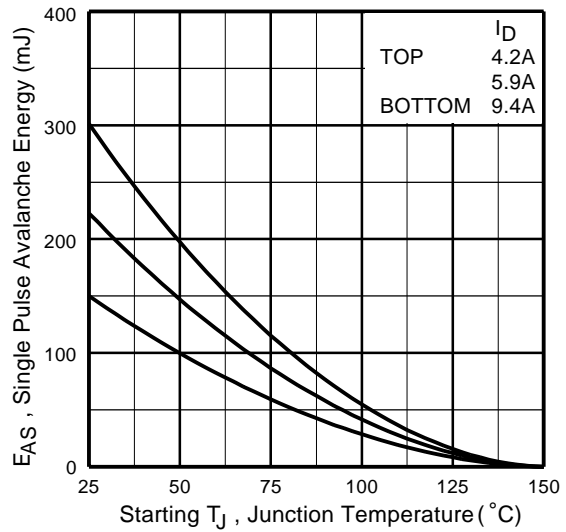


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

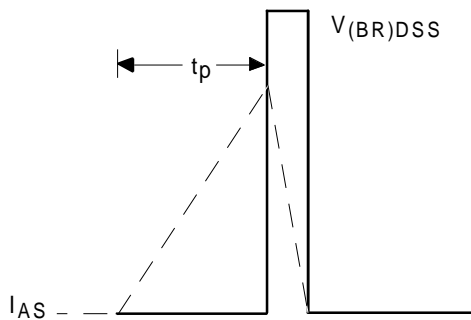


Fig 12b. Unclamped Inductive Waveforms

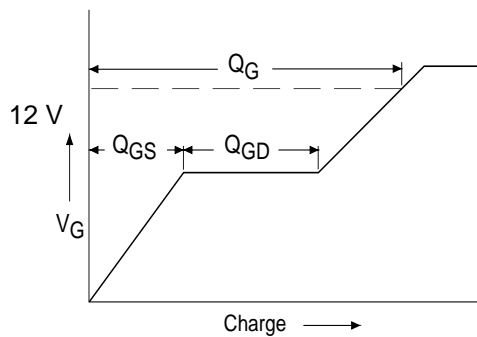


Fig 13a. Basic Gate Charge Waveform

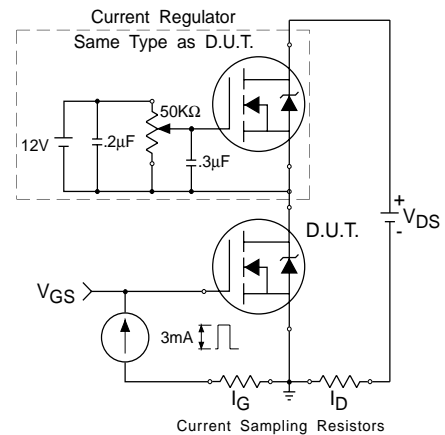
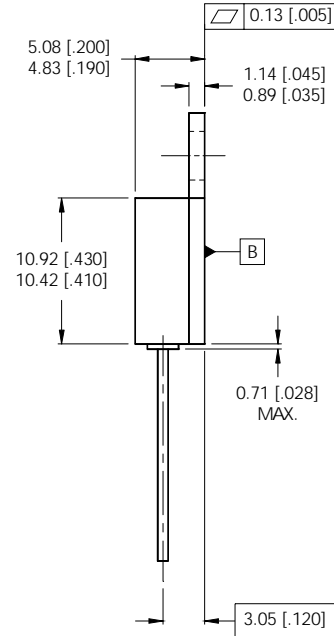
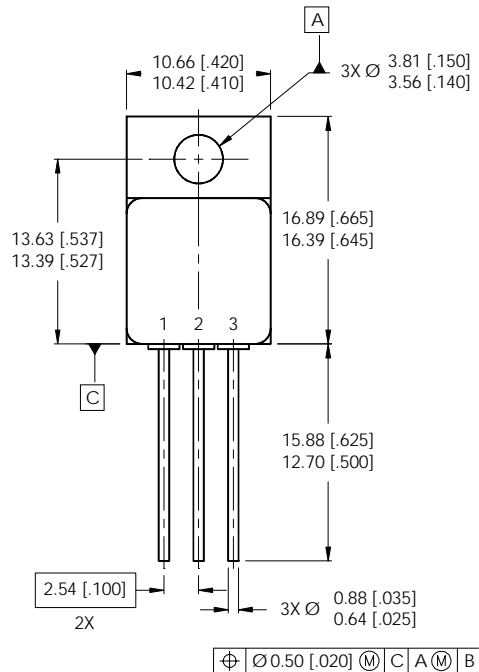


Fig 13b. Gate Charge Test Circuit

**Foot Notes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 50V$ , starting  $T_J = 25^\circ C$ ,  $L=3.40mH$   
Peak  $I_L = 9.4A$ ,  $V_{GS} = 12V$
- ③  $ISD \leq 9.4A$ ,  $di/dt \leq 660A/\mu s$ ,  
 $V_{DD} \leq 200V$ ,  $T_J \leq 150^\circ C$
- 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-257AA**



- NOTES:
1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
  4. OUTLINE CONFORMS TO JEDEC OUTLINE TO-257AA.

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



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