

**RADIATION HARDENED  
 POWER MOSFET  
 THRU-HOLE (Low-Ohmic TO-254AA)**

**IRHMS57160  
 JANSR2N7471T1  
 100V, Quad N-CHANNEL  
 REF: MIL-PRF-19500/698**



**Product Summary**

Part Number	Radiation Level	RDS(on)	Id	QPL Part Number
IRHMS57160	100K Rads (Si)	0.013Ω	45A*	JANSR2N7471T1
IRHMS53160	300K Rads (Si)	0.013Ω	45A*	JANSF2N7471T1
IRHMS54160	500K Rads (Si)	0.013Ω	45A*	JANSG2N7471T1
IRHMS58160	1000K Rads (Si)	0.014Ω	45A*	JANSH2N7471T1



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/cm²)). 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	45*	A
ID @ VGS = 12V, TC = 100°C	Continuous Drain Current	45*	
IDM	Pulsed Drain Current ①	180	
PD @ TC = 25°C	Max. Power Dissipation	208	W
	Linear Derating Factor	1.67	W/°C
VGS	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	493	mJ
IAR	Avalanche Current ①	45	A
EAR	Repetitive Avalanche Energy ①	20.8	mJ
dv/dt	Peak Diode Recovery dv/dt ③	6.7	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	Lead Temperature	300 (0.063 in. /1.6 mm from case for 10s)	
	Weight	9.3 (Typical)	g

\* Current is limited by package  
 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	100	—	—	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	—	0.11	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.013	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A 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	42	—	—	S	V <sub>DS</sub> = 15V, I <sub>DS</sub> = 45A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	10	μA	V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V
		—	—	25		V <sub>DS</sub> = 80V, 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	—	—	160	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	55		V <sub>DS</sub> = 50V
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	65		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	35	ns	V <sub>DD</sub> = 50V, I <sub>D</sub> = 45A
t <sub>r</sub>	Rise Time	—	—	125		V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	75		
t <sub>f</sub>	Fall Time	—	—	50		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	6.8	—	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
C <sub>iss</sub>	Input Capacitance	—	6270	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V
C <sub>oss</sub>	Output Capacitance	—	1620	—		f = 1.0MHz
C <sub>rss</sub>	Reverse Transfer Capacitance	—	35	—		
R <sub>g</sub>	Internal Gate Resistance	—	1.0	—		Ω

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	45*	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	180		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.2	V	T <sub>j</sub> = 25°C, I <sub>S</sub> = 45A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	270	ns	T <sub>j</sub> = 25°C, I <sub>F</sub> = 45A, di/dt ≤ 100A/μs
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	2.7	μC	V <sub>DD</sub> ≤ 50V 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> .				

\* Current is limited by package

**Thermal Resistance**

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	0.60	°C/W	
R <sub>thCS</sub>	Case-to-Sink	—	0.21	—		
R <sub>thJA</sub>	Junction-to-Ambient	—	—	48		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

## IRHMS57160, JANSR2N7471T1

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 500K 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	100	—	100	—	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	—	25	μA	V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance (TO-3)	—	0.013	—	0.014	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance (Low-Ohmic TO-254)	—	0.013	—	0.014	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A
V <sub>SD</sub>	Diode Forward Voltage ④	—	1.2	—	1.2	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 45A

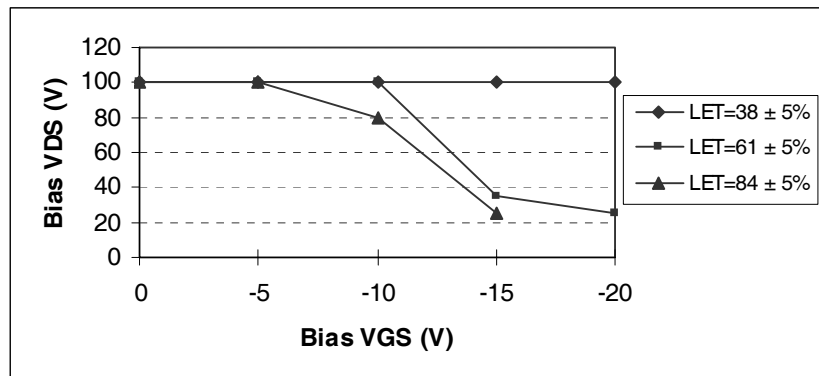
1. Part numbers IRHMS57160 (JANSR2N7471T1), IRHMS53160 (JANSF2N7471T1) and IRHMS54160 (JANSR2N7471T1)

2. Part number IRHMS58160 (JANSH2N7471T1)

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. Typical Single Event Effect Safe Operating Area**

LET (MeV/(mg/cm <sup>2</sup> ))	Energy (MeV)	Range (μm)	VDS (V)				
			@VGS = 0V	@VGS = -5V	@VGS = -10V	@VGS = -15V	@VGS = -20V
38 ± 5%	300 ± 7.5%	38 ± 7.5%	100	100	100	100	100
61 ± 5%	330 ± 7.5%	31 ± 10%	100	100	100	35	25
84 ± 5%	350 ± 10%	28 ± 7.5%	100	100	80	25	-



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

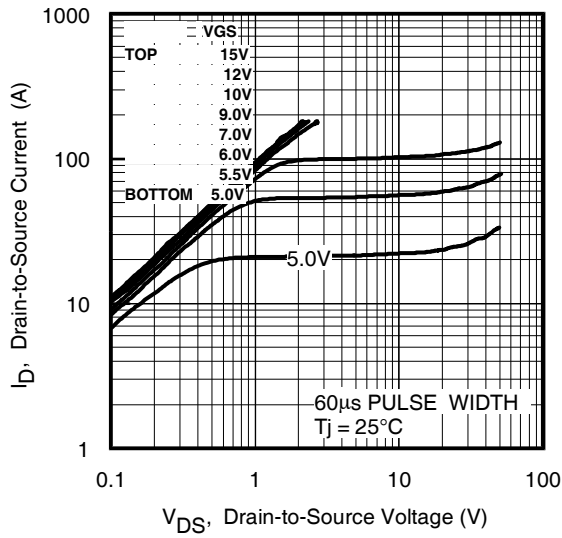


Fig 1. Typical Output Characteristics

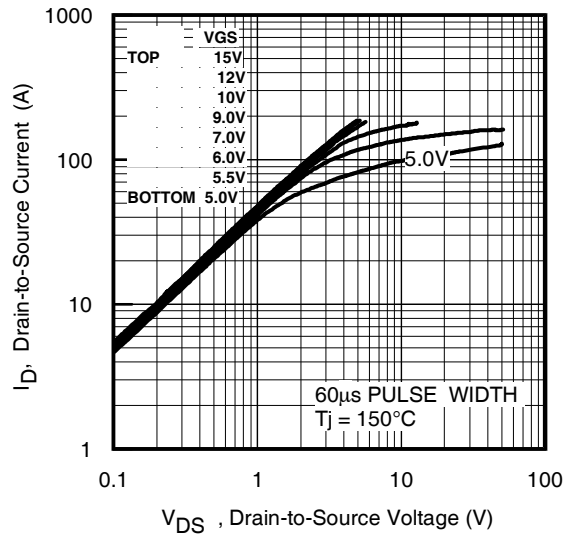


Fig 2. Typical Output Characteristics

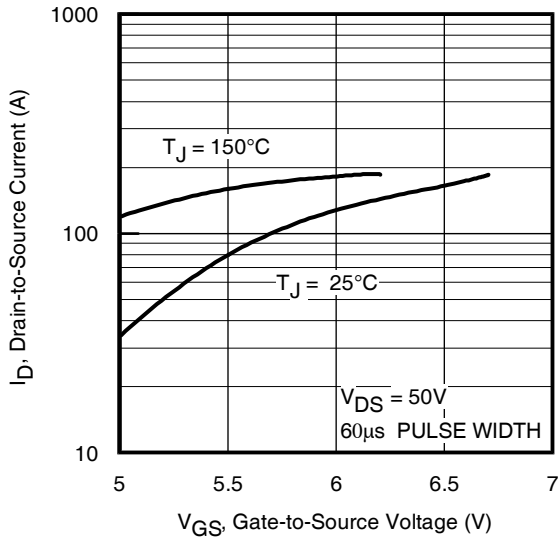


Fig 3. Typical Transfer Characteristics

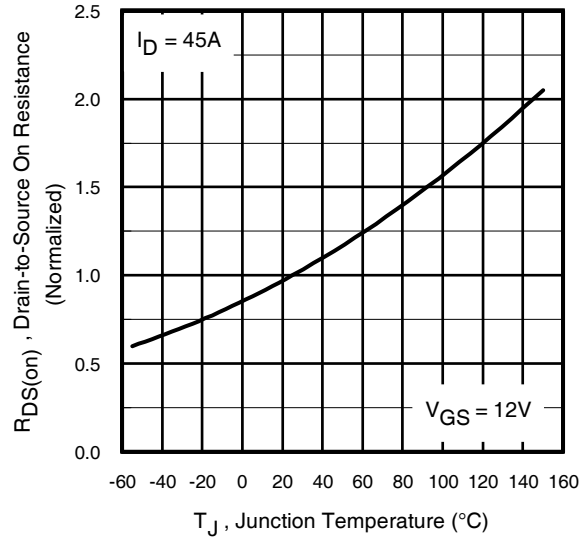


Fig 4. Normalized On-Resistance Vs. Temperature

Pre-Irradiation

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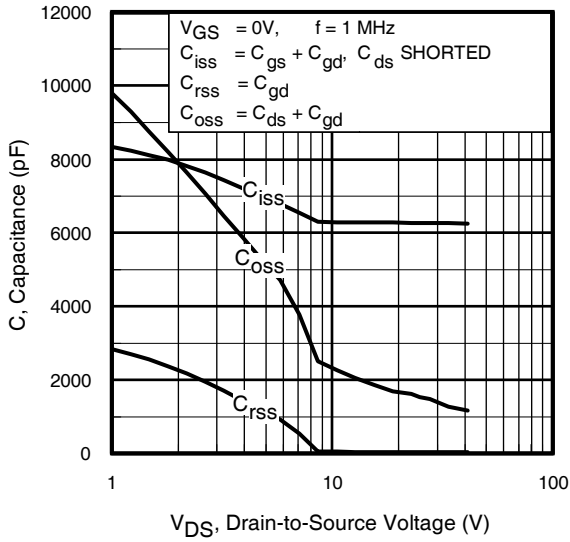


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

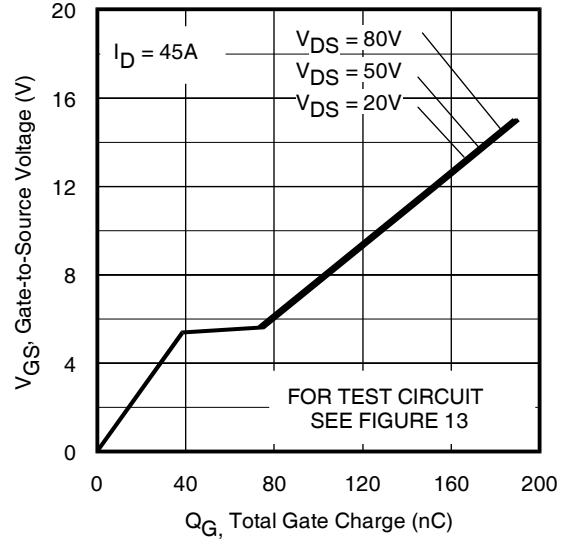


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

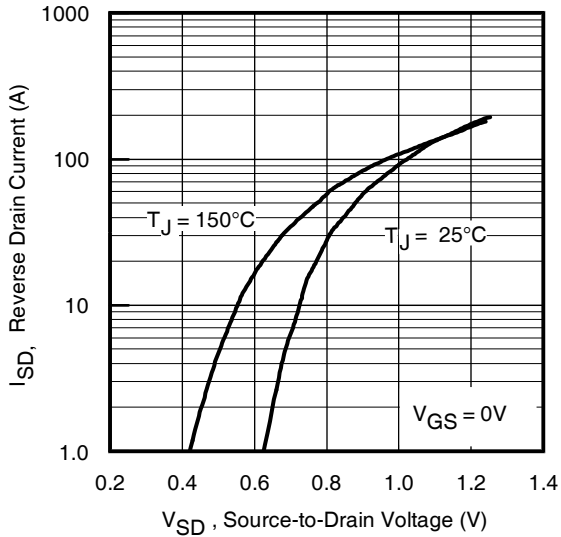


Fig 7. Typical Source-Drain Diode Forward Voltage

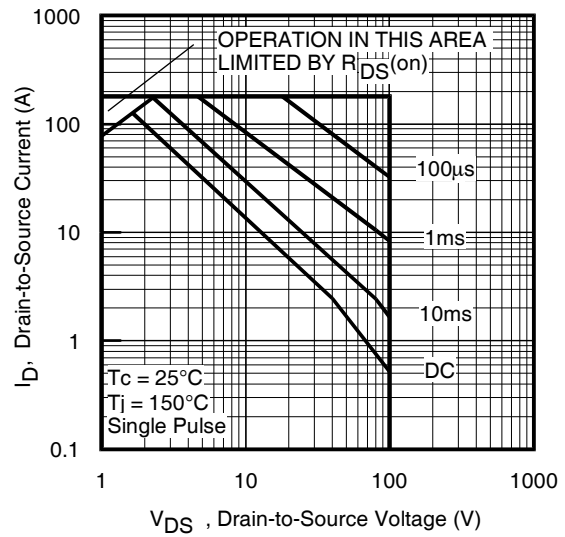
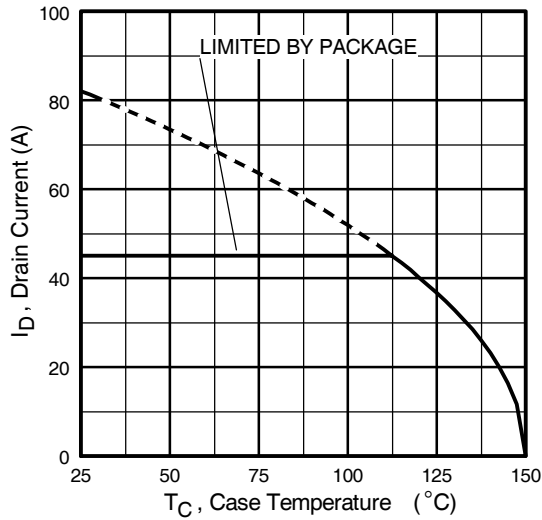
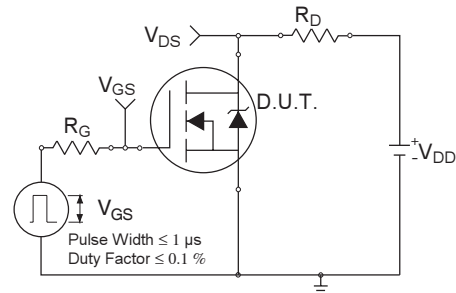


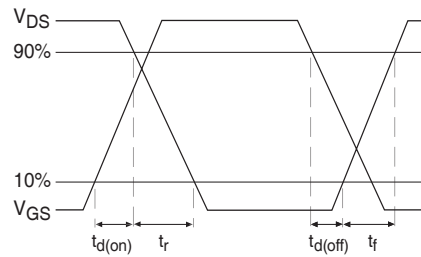
Fig 8. Maximum Safe Operating Area



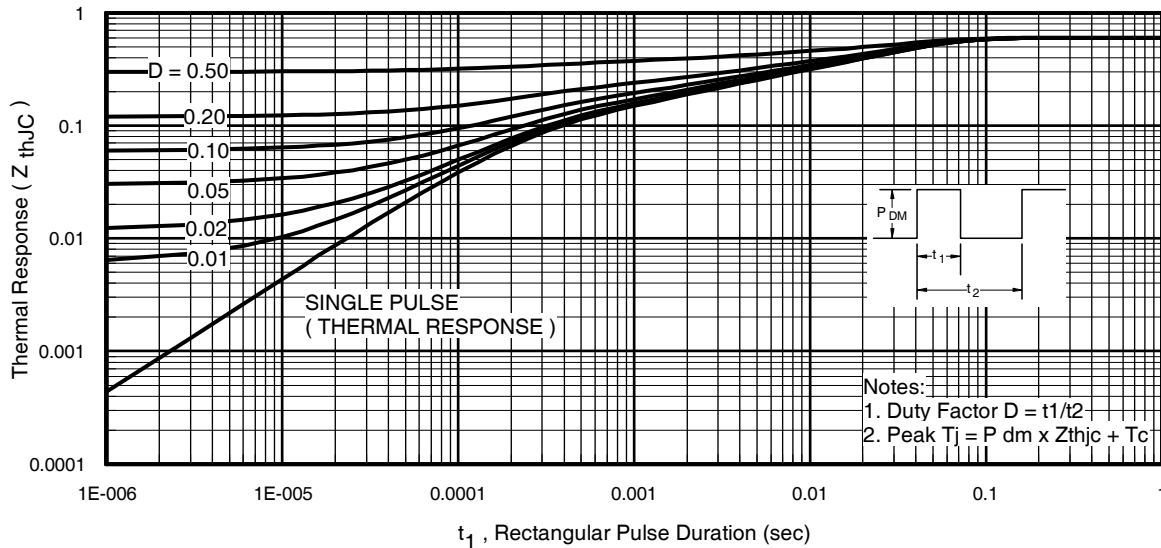
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



**Fig 10b.** Switching Time Waveforms



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

Pre-Irradiation

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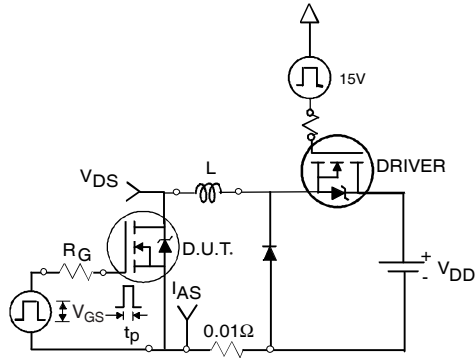


Fig 12a. Unclamped Inductive Test Circuit

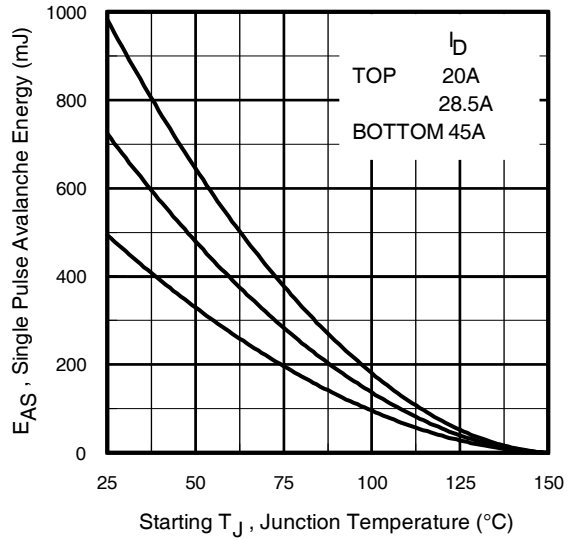


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

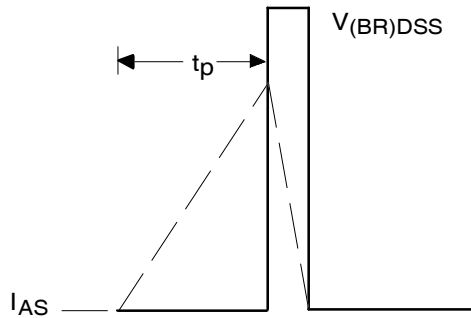


Fig 12b. Unclamped Inductive Waveforms

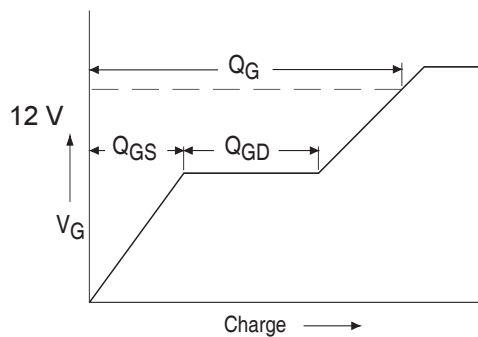


Fig 13a. Basic Gate Charge Waveform

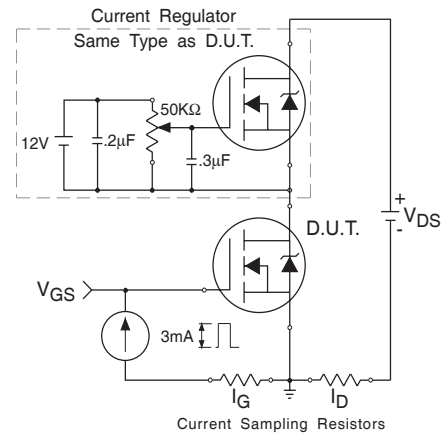


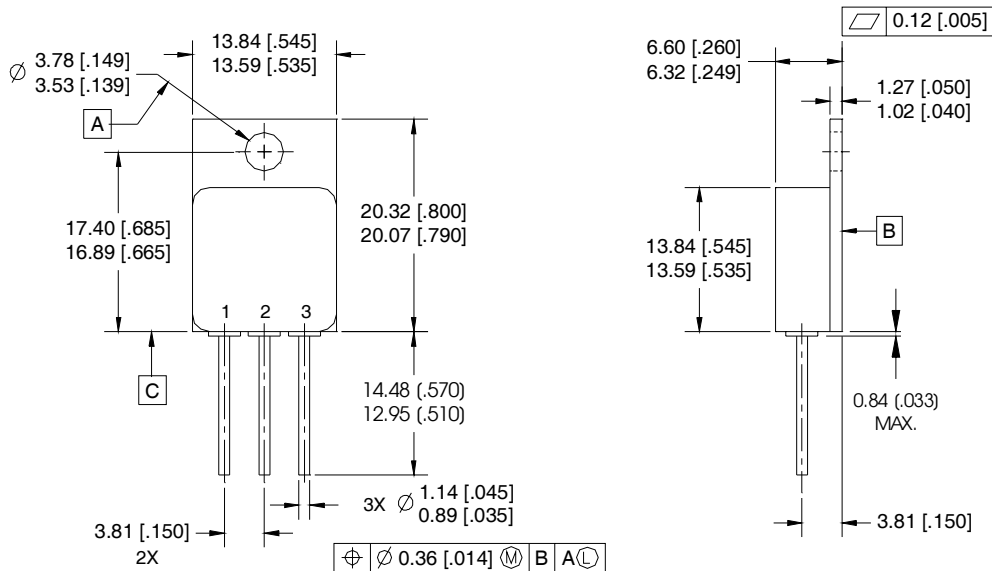
Fig 13b. Gate Charge Test Circuit

**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L = 0.49\text{ mH}$   
Peak  $I_L = 45A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 45A$ ,  $di/dt \leq 630A/\mu s$ ,  
 $V_{DD} \leq 100V$ ,  $T_J \leq 150^\circ C$

- ④ Pulse width  $\leq 300\ \mu s$ ; Duty Cycle  $\leq 2\%$
- ⑤ **Total Dose Irradiation with VGS 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 VDS Bias.**  
80 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-254AA**



NOTES:

- 1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
- 2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- 3. CONTROLLING DIMENSION: INCH.
- 4. CONFORMS TO JEDEC OUTLINE TO-254AA.

PIN ASSIGNMENTS

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

**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.



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Data and specifications subject to change without notice. 10/2011