

**RADIATION HARDENED
POWER MOSFET
SURFACE MOUNT (SMD-0.5)**

**IRHNJ67230
JANSR2N7591U3
200V, N-CHANNEL
REF: MIL-PRF-19500/746
R6 TECHNOLOGY**

Product Summary

Part Number	Radiation Level	R _{DS(on)}	I _D	QPL Part Number
IRHNJ67230	100K Rads (Si)	0.13Ω	16A	JANSR2N7591U3
IRHNJ63230	300K Rads (Si)	0.13Ω	16A	JANSF2N7591U3



International Rectifier's R6™ technology provides superior power MOSFETs for space applications. These devices have improved immunity to Single Event Effect (SEE) and have been characterized for useful performance with Linear Energy Transfer (LET) up to 90MeV/(mg/cm²). Their combination of very low R_{DS(on)} and faster switching times reduces power loss and increases power density in today's high speed switching applications such as DC-DC converters and motor controllers. These devices retain all of the well established advantages of MOSFETs such as voltage control, ease of paralleling and temperature stability of electrical parameters.

Features:

- Low R_{DS(on)}
- Fast Switching
- Single Event Effect (SEE) Hardened
- 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°C	Continuous Drain Current	19	A
I _D @ V _{GS} = 12V, T _C = 100°C	Continuous Drain Current	12	
I _{DM}	Pulsed Drain Current ①	76	
P _D @ T _C = 25°C	Max. Power Dissipation	75	W
	Linear Derating Factor	0.6	W/°C
V _{GS}	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	60	mJ
I _{AR}	Avalanche Current ①	19	A
EAR	Repetitive Avalanche Energy ①	7.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	8.6	V/ns
T _J	Operating Junction	-55 to 150	°C
T _{STG}	Storage Temperature Range		
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	1.0 (Typical)	g

For footnotes refer to the last page

Electrical Characteristics @ T_j = 25°C (Unless Otherwise Specified)

	Parameter	Min	Typ	Max	Units	Test Conditions
BVDSS	Drain-to-Source Breakdown Voltage	200	—	—	V	V _{GS} = 0V, I _D = 1.0mA
ΔBVDSS/ΔT _J	Temperature Coefficient of Breakdown Voltage	—	0.22	—	V/°C	Reference to 25°C, I _D = 1.0mA
RDS(on)	Static Drain-to-Source On-State Resistance	—	—	0.13	Ω	V _{GS} = 12V, I _D = 10A ④
VGS(th)	Gate Threshold Voltage	2.0	—	4.0	V	V _{DS} = V _{GS} , I _D = 1.0mA
ΔVGS(th)/ΔT _J	Gate Threshold Voltage Coefficient	—	-10.25	—	mV/°C	
gfs	Forward Transconductance	10	—	—	S	V _{DS} = 15V, I _{DS} = 10A ④
I _{DSS}	Zero Gate Voltage Drain Current	—	—	10	μA	V _{DS} = 160V, V _{GS} = 0V
		—	—	25		V _{DS} = 160V, V _{GS} = 0V, T _J = 125°C
I _{GSS}	Gate-to-Source Leakage Forward	—	—	100	nA	V _{GS} = 20V
I _{GSS}	Gate-to-Source Leakage Reverse	—	—	-100		V _{GS} = -20V
Q _g	Total Gate Charge	—	—	42	nC	V _{GS} = 12V, I _D = 16A
Q _{gs}	Gate-to-Source Charge	—	—	15		V _{DS} = 100V
Q _{gd}	Gate-to-Drain ('Miller') Charge	—	—	15		
t _{d(on)}	Turn-On Delay Time	—	—	18	ns	V _{DD} = 100V, I _D = 16A, V _{GS} = 12V, R _G = 7.5Ω
t _r	Rise Time	—	—	32		
t _{d(off)}	Turn-Off Delay Time	—	—	41		
t _f	Fall Time	—	—	10		
L _S + L _D	Total Inductance	—	4.0	—	nH	Measured from the center of drain pad to center of source pad
C _{iss}	Input Capacitance	—	1450	—	pF	V _{GS} = 0V, V _{DS} = 25V
C _{oss}	Output Capacitance	—	210	—		f = 1.0MHz
C _{rss}	Reverse Transfer Capacitance	—	3.8	—		
R _g	Gate Resistance	—	0.9	—	Ω	f = 1.0MHz, open drain

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	16	A	
I _{SM}	Pulse Source Current (Body Diode) ①	—	—	64		
V _{SD}	Diode Forward Voltage	—	—	1.2	V	T _j = 25°C, I _S = 16A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	—	346	ns	T _j = 25°C, I _F = 16A, di/dt ≤ 100A/μs
Q _{RR}	Reverse Recovery Charge	—	—	3.5	μC	V _{DD} ≤ 25V ④
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L _S + L _D .				

* Current is limited by package

Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R _{thJC}	Junction-to-Case	—	—	1.67	°C/W	

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

For footnotes refer to the last page

Radiation Characteristics

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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	Up to 300K Rads (Si) ¹		Units	Test Conditions
		Min	Max		
BV_{DS}	Drain-to-Source Breakdown Voltage	200	—	V	$V_{GS} = 0V, I_D = 1.0mA$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0		$V_{GS} = V_{DS}, I_D = 1.0mA$
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	—	10	μA	$V_{DS} = 160V, V_{GS} = 0V$
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.134	Ω	$V_{GS} = 12V, I_D = 10A$
$R_{DS(on)}$	Static Drain-to-Source On-State ④ Resistance (SMD-0.5)	—	0.130	Ω	$V_{GS} = 12V, I_D = 10A$
V_{SD}	Diode Forward Voltage ④	—	1.2	V	$V_{GS} = 0V, I_D = 16A$

1. Part numbers IRHNJ67230 (JANSR2N7591U3) and IRHNJ63230 (JANSF2N7591U3)

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 ²))	Energy (MeV)	Range (μm)	VDS (V)			
			@VGS=0V	@VGS=-5V	@VGS=-10V	@VGS=-15V
42 $\pm$ 5%	2450 $\pm$ 5%	205 $\pm$ 5%	200	200	200	190
61 $\pm$ 5%	825 $\pm$ 5%	66 $\pm$ 7.5%	200	200	200	190
90 $\pm$ 5%	1470 $\pm$ 5%	80 $\pm$ 5%	170	170	-	-

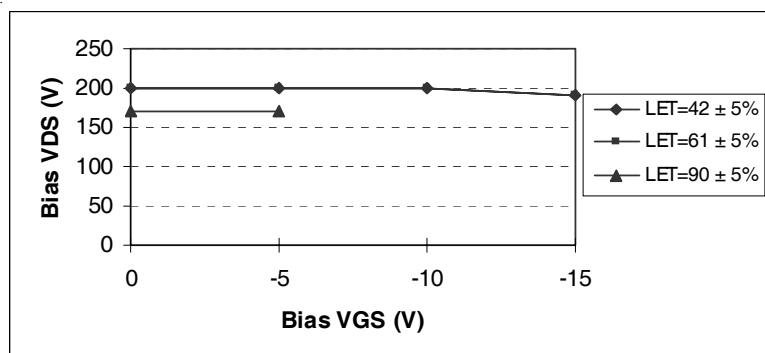


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the last page

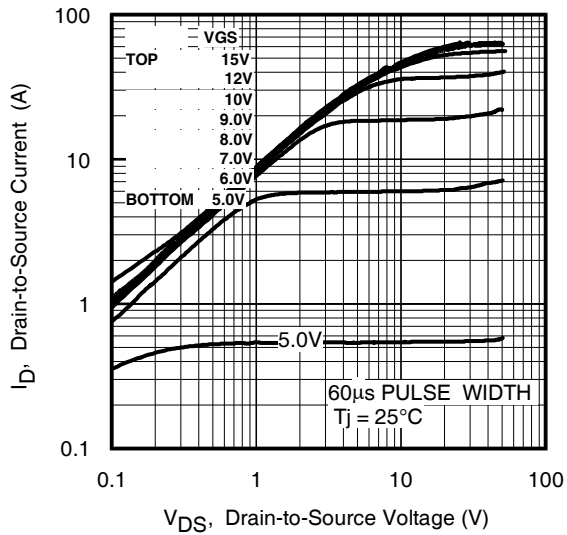


Fig 1. Typical Output Characteristics

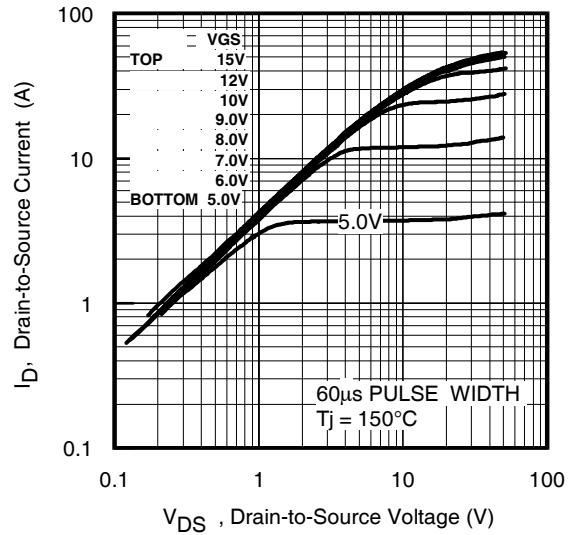


Fig 2. Typical Output Characteristics

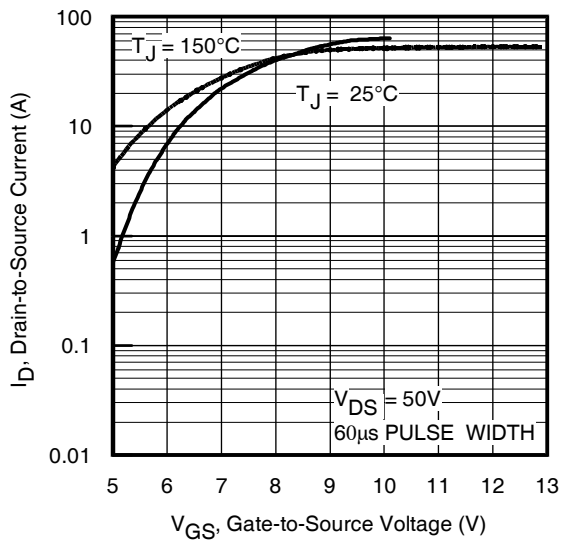


Fig 3. Typical Transfer Characteristics

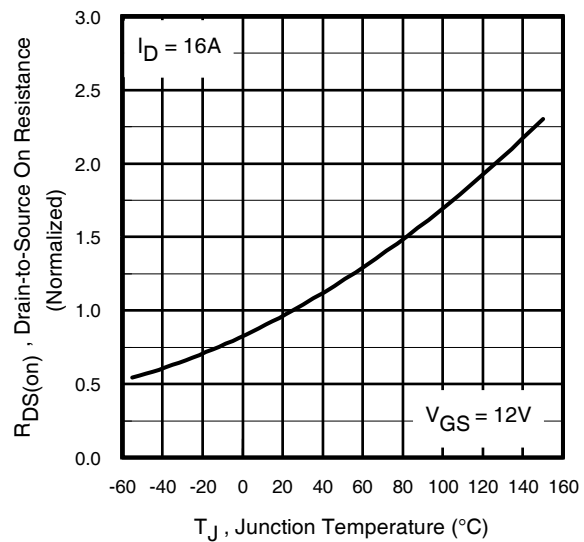


Fig 4. Normalized On-Resistance Vs. Temperature

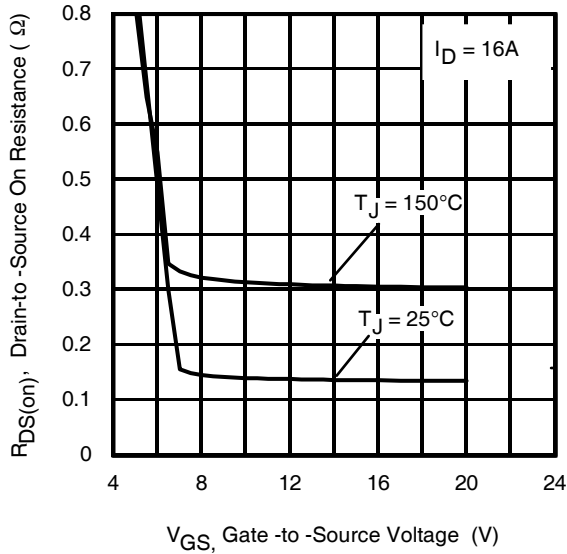


Fig 5. Typical On-Resistance Vs Gate Voltage

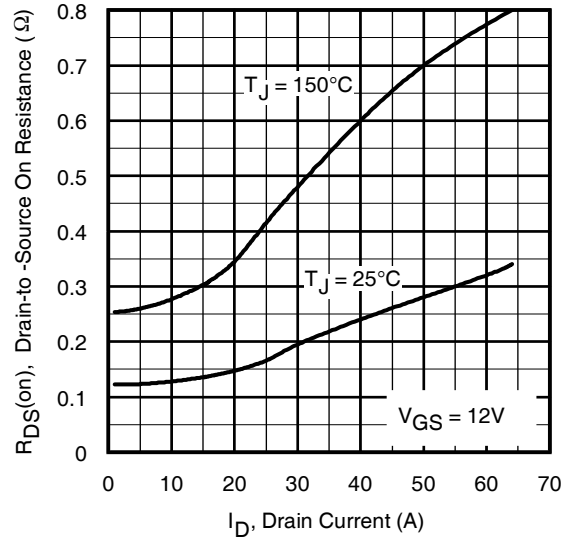


Fig 6. Typical On-Resistance Vs Drain Current

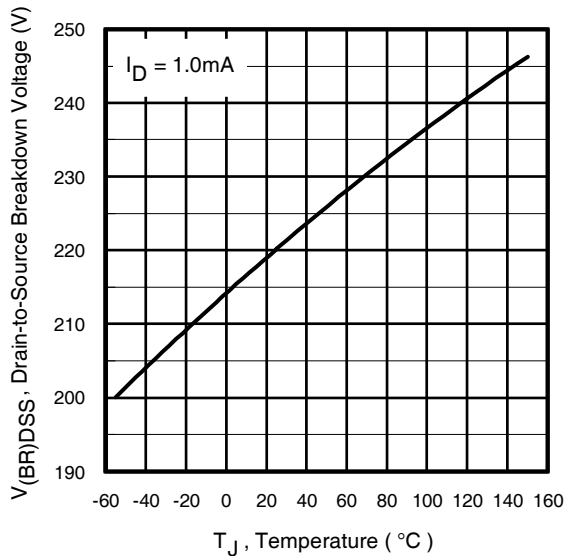


Fig 7. Typical Drain-to-Source Breakdown Voltage Vs Temperature

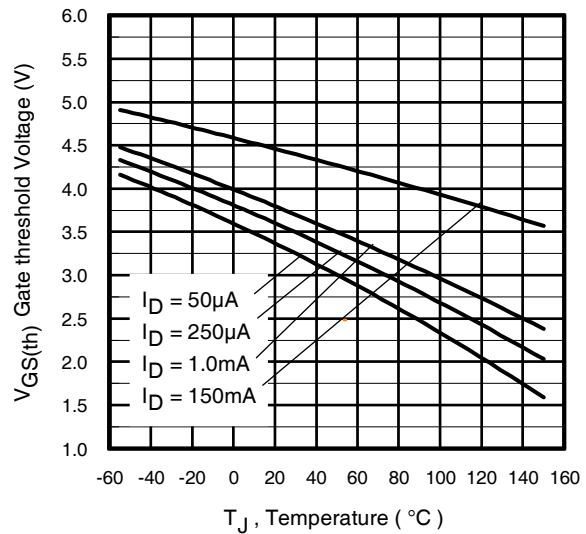


Fig 8. Typical Threshold Voltage Vs Temperature

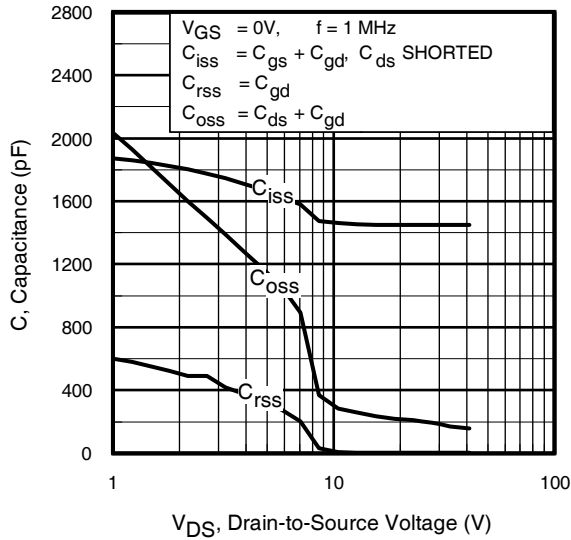


Fig 9. Typical Capacitance Vs. Drain-to-Source Voltage

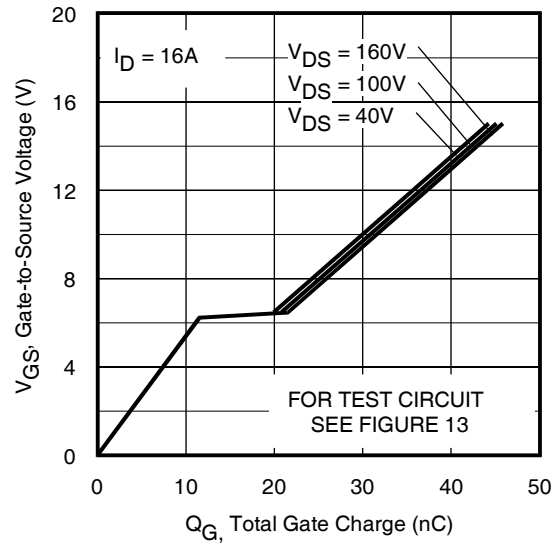


Fig 10. Typical Gate Charge Vs. Gate-to-Source Voltage

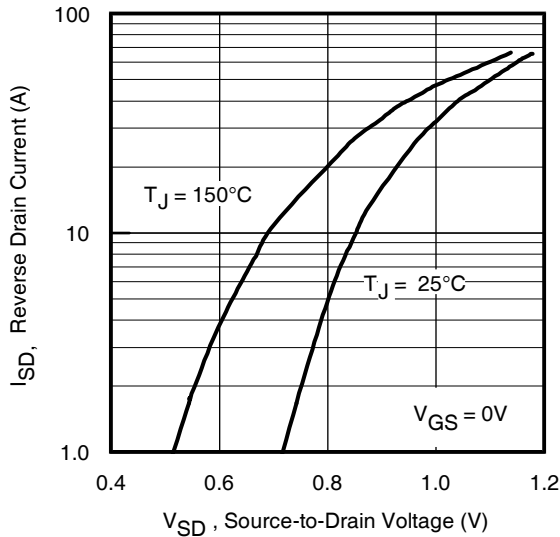


Fig 11. Typical Source-Drain Diode Forward Voltage

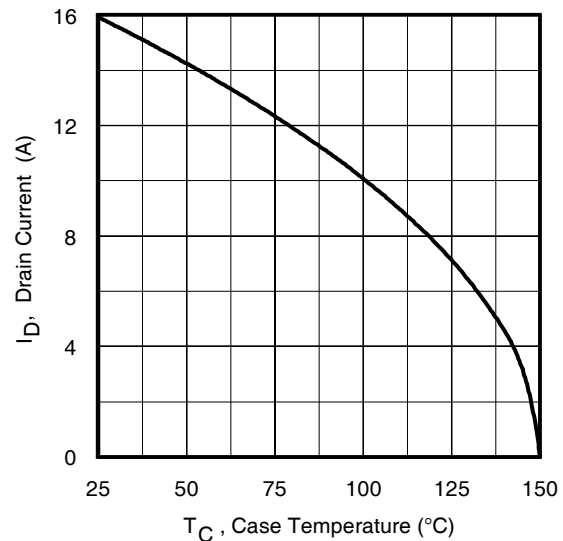


Fig 12. Maximum Drain Current Vs. Case Temperature

Pre-Irradiation

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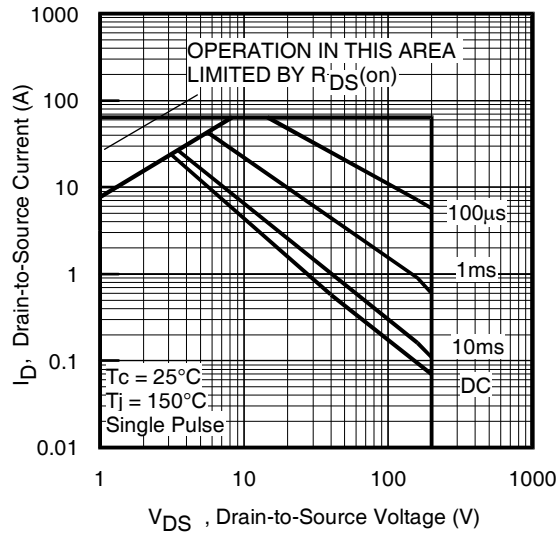


Fig 13. Maximum Safe Operating Area

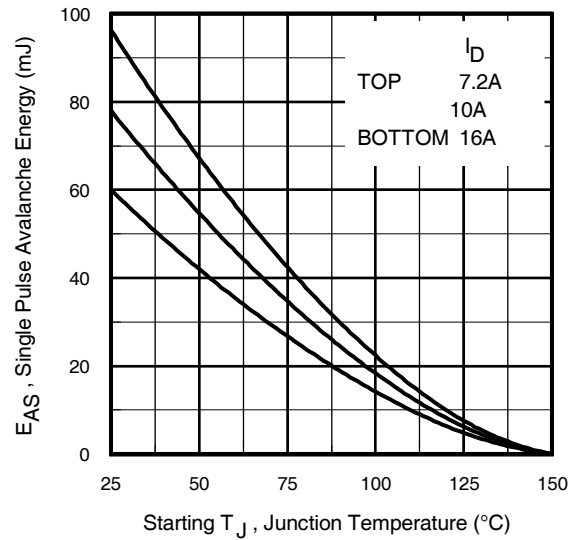


Fig 14. Maximum Avalanche Energy Vs. Drain Current

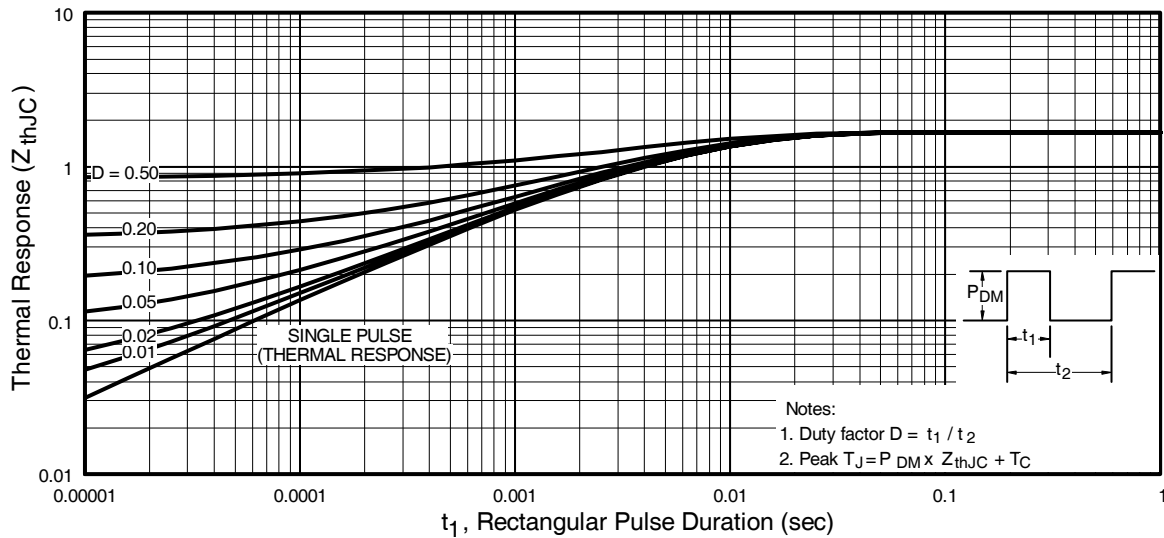


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

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Pre-Irradiation

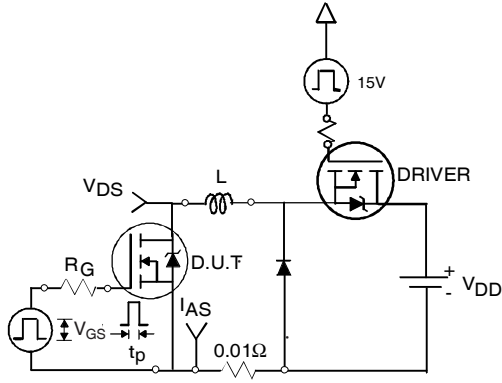


Fig 16a. Unclamped Inductive Test Circuit

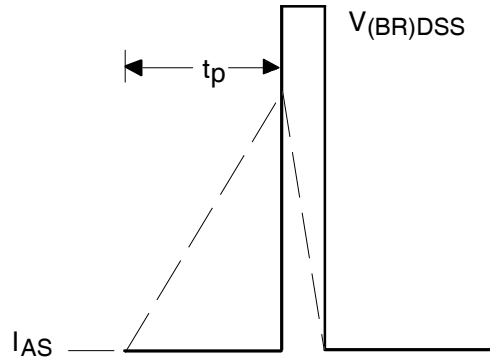


Fig 16b. Unclamped Inductive Waveforms

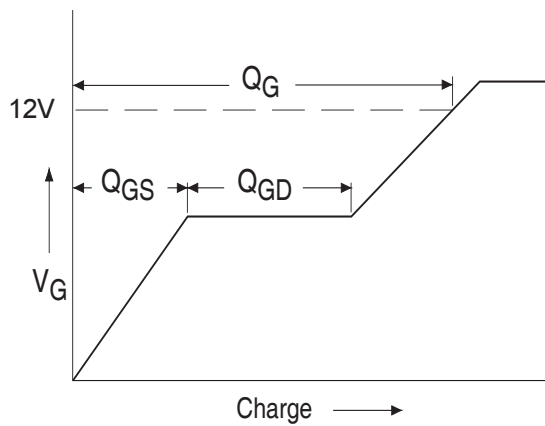


Fig 17a. Basic Gate Charge Waveform

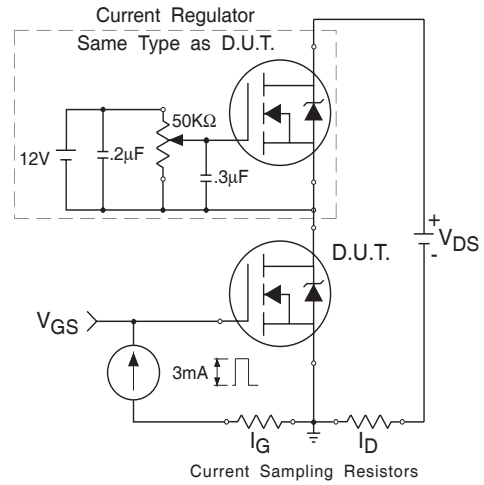


Fig 17b. Gate Charge Test Circuit

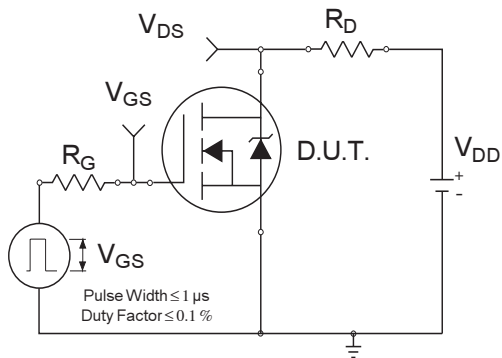


Fig 18a. Switching Time Test Circuit

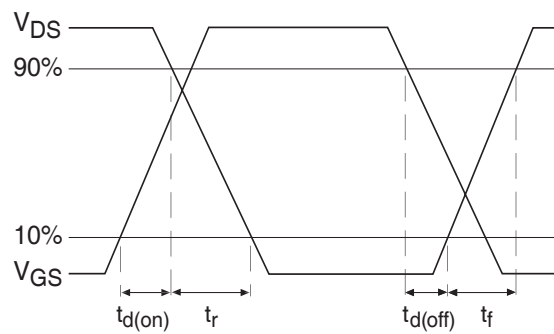


Fig 18b. Switching Time Waveforms

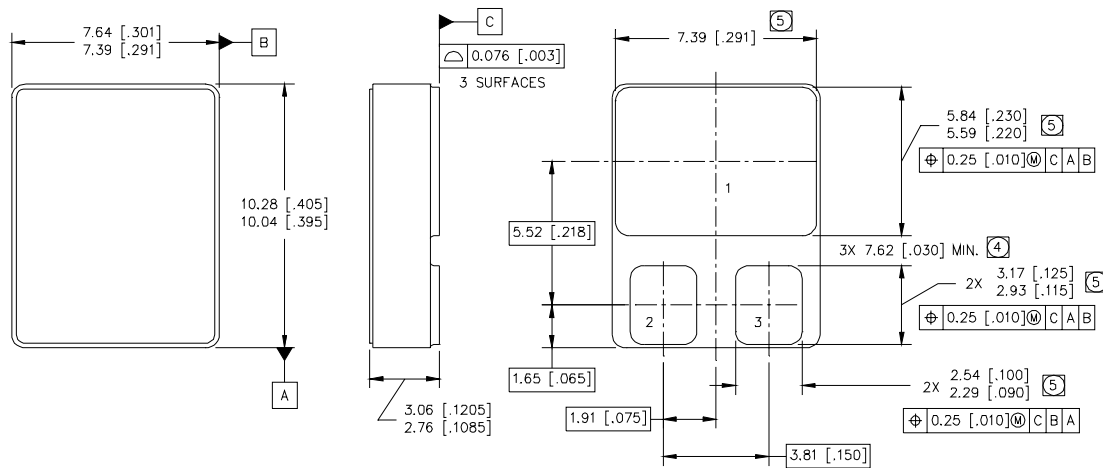
Pre-Irradiation

IRHNJ67230, JANSR2N7591U3

Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② $V_{DD} = 25V$, starting $T_J = 25^\circ C$, $L = 0.47mH$
Peak $I_L = 16A$, $V_{GS} = 12V$
- ③ $I_{SD} \leq 16A$, $di/dt \leq 570A/\mu s$,
 $V_{DD} \leq 200V$, $T_J \leq 150^\circ C$
- 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 — SMD-0.5



NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- ④ DIMENSION INCLUDES METALLIZATION FLASH.
- ⑤ DIMENSION DOES NOT INCLUDE METALLIZATION FLASH.

PAD ASSIGNMENTS

- 1 = DRAIN
2 = GATE
3 = SOURCE

International
IR Rectifier

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Data and specifications subject to change without notice. 11/2010