

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

PD-96961A

**IRHMS57Z60**  
**JANSR2N7478T1**  
**30V, N-CHANNEL**  
**REF: MIL-PRF-19500/697**



**Product Summary**

Part Number	Radiation Level	RDS(on)	Id	QPL Part Number
IRHMS57Z60	100K Rads (Si)	0.0045Ω	45A*	JANSR2N7478T1
IRHMS53Z60	300K Rads (Si)	0.0045Ω	45A*	JANSF2N7478T1
IRHMS54Z60	500K Rads (Si)	0.0045Ω	45A*	JANSG2N7478T1
IRHMS58Z60	1000K Rads (Si)	0.0045Ω	45A*	JANSH2N7478T1



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 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	1250	mJ
IAR	Avalanche Current ①	45	A
EAR	Repetitive Avalanche Energy ①	20.8	mJ
dv/dt	Peak Diode Recovery dv/dt ③	1.08	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	30	—	—	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	—	0.03	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.0045	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	73	—	—	S (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> = 24V, V <sub>GS</sub> = 0V
		—	—	25		V <sub>DS</sub> = 24V, 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	—	—	240	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	60		V <sub>DS</sub> = 15V
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	55		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	35	ns	V <sub>DD</sub> = 15V, I <sub>D</sub> = 45A V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω
t <sub>r</sub>	Rise Time	—	—	175		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	80		
t <sub>f</sub>	Fall Time	—	—	40		
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	—	8884	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	4334	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	270	—		
R <sub>g</sub>	Internal Gate Resistance	—	0.73	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	45*	A	T <sub>j</sub> = 25°C, I <sub>S</sub> = 45A, V <sub>GS</sub> = 0V ④
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>F</sub> = 45A, di/dt ≤ 100A/μs
t <sub>rr</sub>	Reverse Recovery Time	—	—	140	ns	V <sub>DD</sub> ≤ 25V ④
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	350	nC	
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	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 International Rectifier Web site.

For footnotes refer to the last page

## Radiation Characteristics

## IRHMS57Z60, JANSR2N7478T1

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** <sup>⑤⑥</sup>

	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	30	—	30	—	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> = -20 V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	10	—	25	μA	V <sub>DS</sub> = 24V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance (TO-3)	—	0.0040	—	0.0045	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)	—	0.0045	—	0.0050	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 45A
V <sub>SD</sub>	Diode Forward Voltage <sup>④</sup>	—	1.2	—	1.2	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 45A

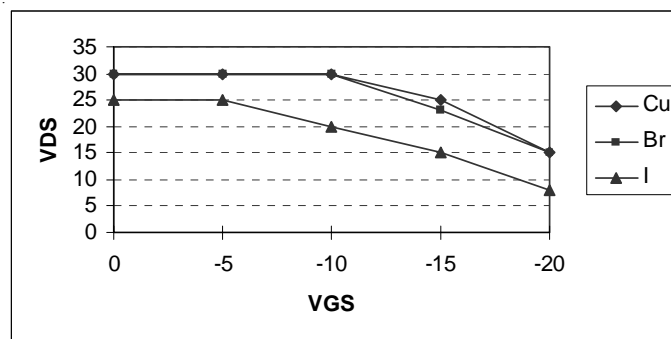
1. Part numbers IRHMS57Z60 (JANSR2N7478T1), IRHMS53Z60 (JANSF2N7478T1) and IRHMS54Z60 (JANSJ2N7478T1)

2. Part number IRHMS58Z60 (JANSH2N7478T1)

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
Cu	28	261	40	30	30	30	25	15
Br	37	285	37	30	30	30	23	15
I	60	344	33	25	25	20	15	8



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

For footnotes refer to the last page

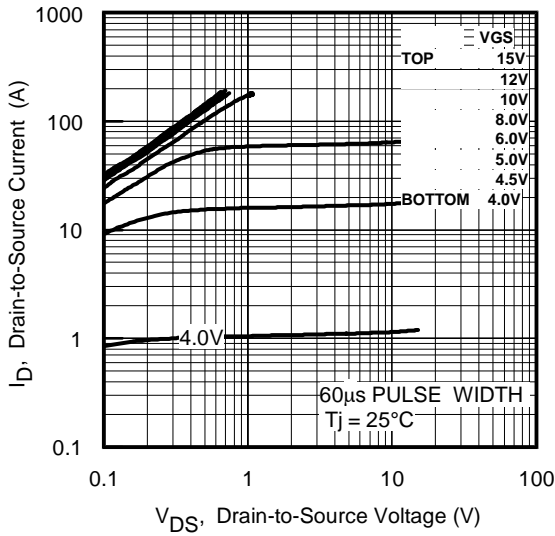


Fig 1. Typical Output Characteristics

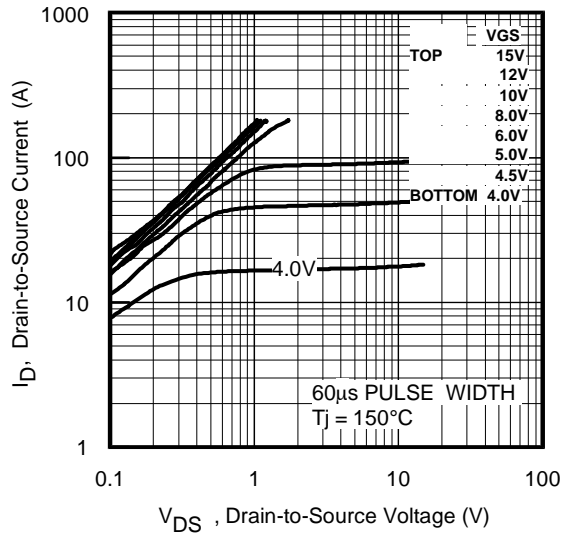


Fig 2. Typical Output Characteristics

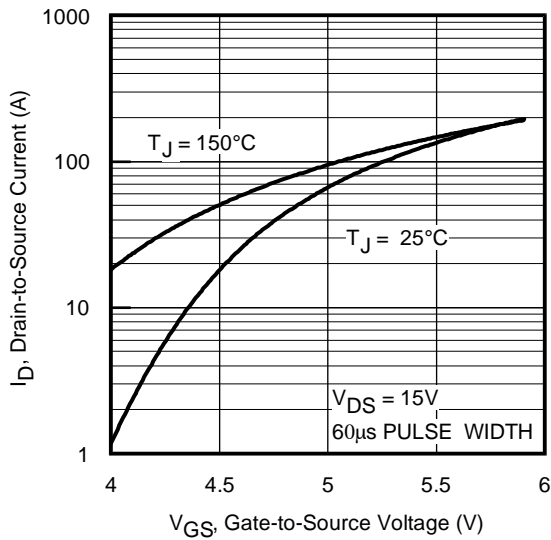


Fig 3. Typical Transfer Characteristics

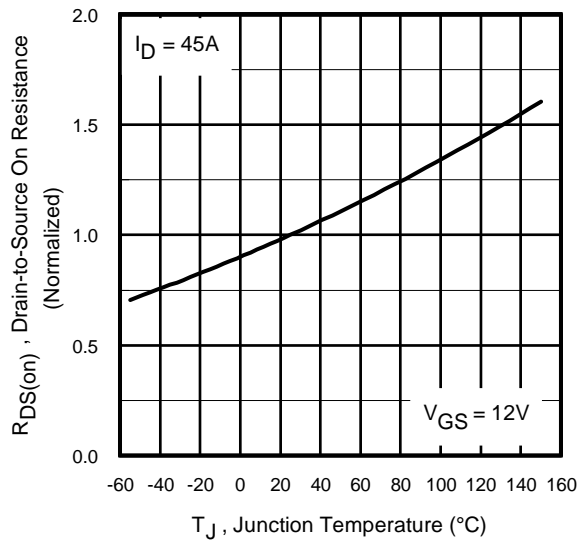


Fig 4. Normalized On-Resistance Vs. Temperature

Pre-Irradiation

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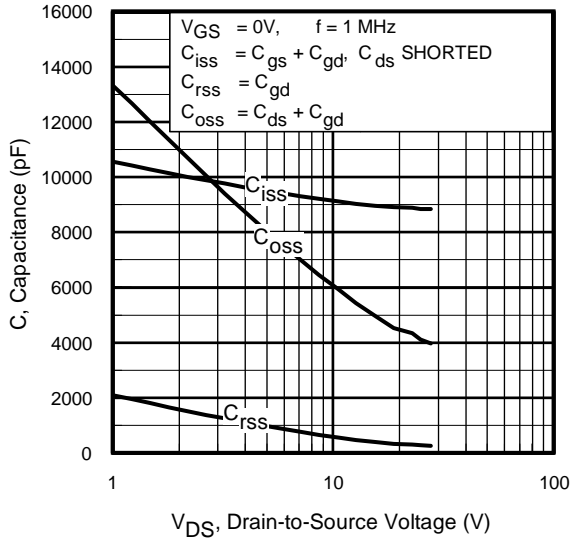


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

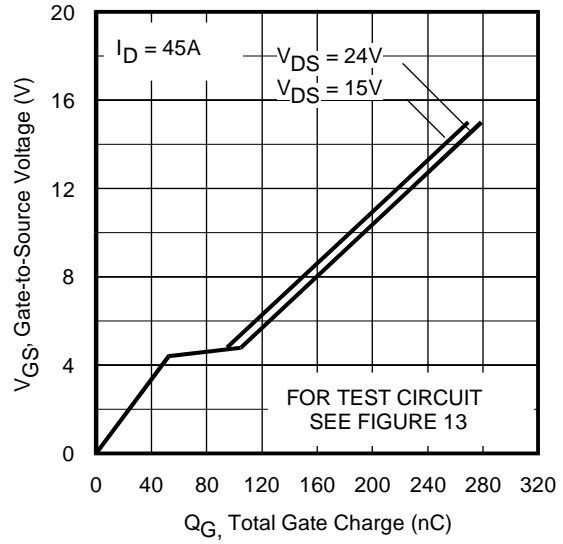


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

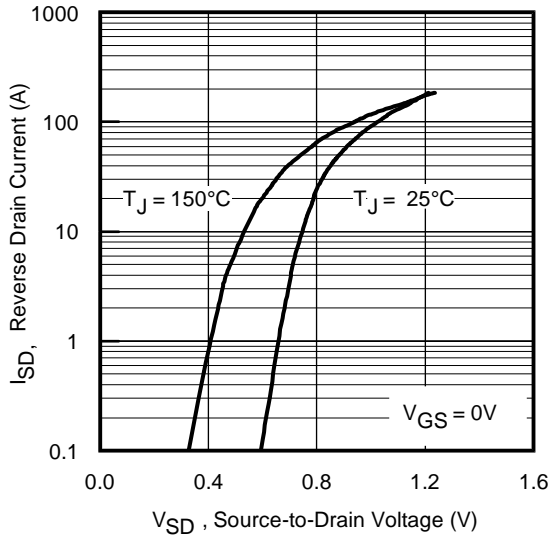


Fig 7. Typical Source-Drain Diode Forward Voltage

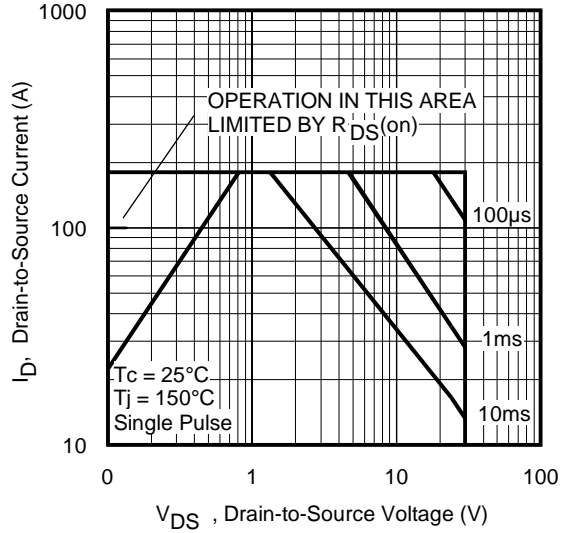


Fig 8. Maximum Safe Operating Area

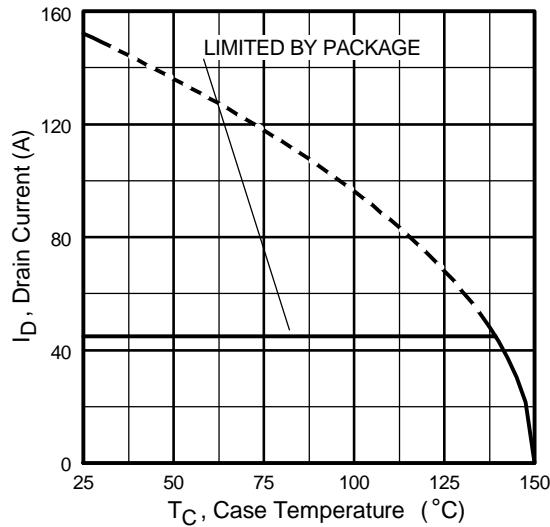


Fig 9. Maximum Drain Current Vs. Case Temperature

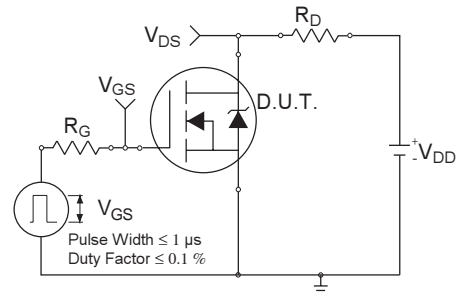


Fig 10a. Switching Time Test Circuit

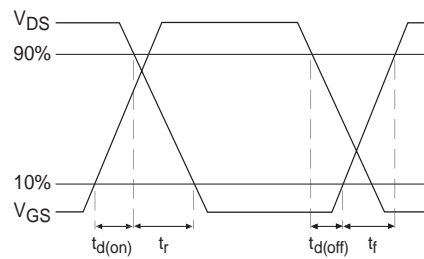


Fig 10b. Switching Time Waveforms

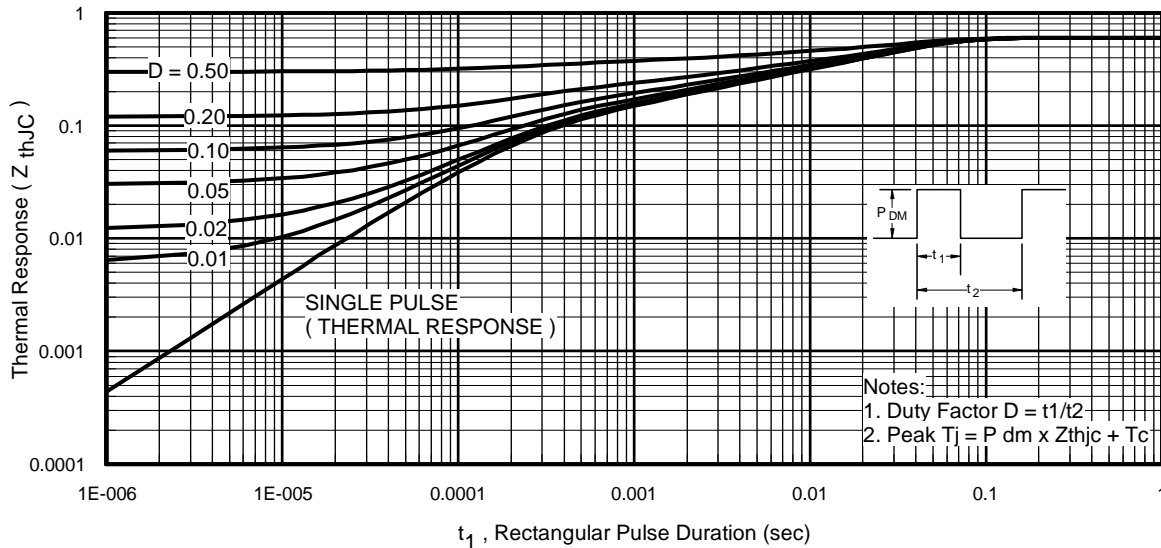


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

Pre-Irradiation

IRHMS57Z60, JANSR2N7478T1

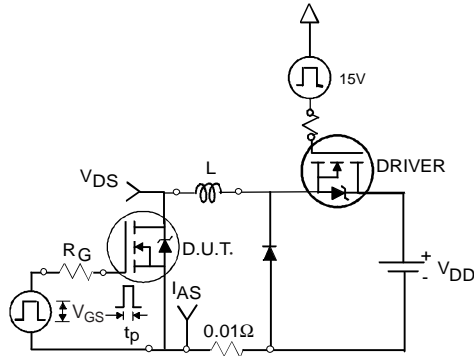


Fig 12a. Unclamped Inductive Test Circuit

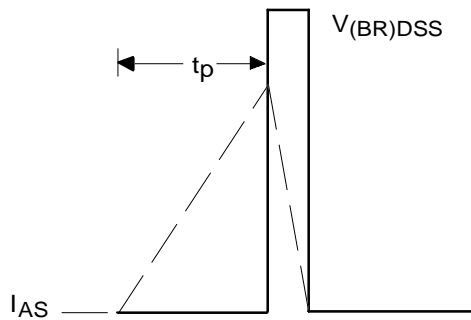


Fig 12b. Unclamped Inductive Waveforms

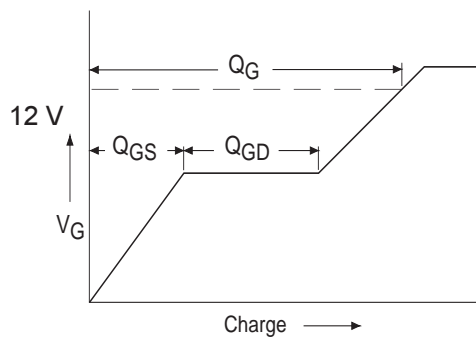
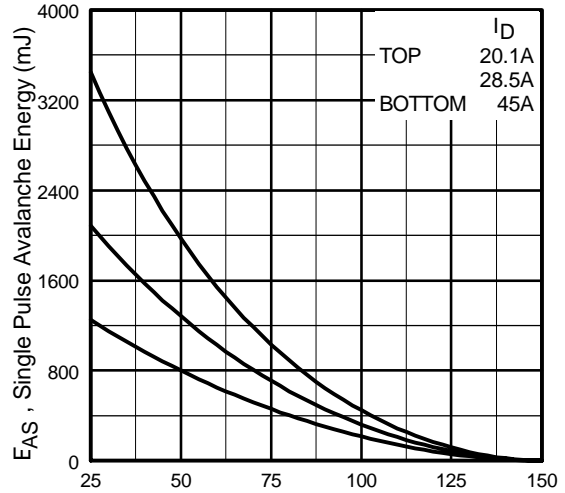


Fig 13a. Basic Gate Charge Waveform



Starting  $T_j$  , - Junction Temperature (°C)

Fig 12c. Maximum Avalanche Energy Vs. Drain Current

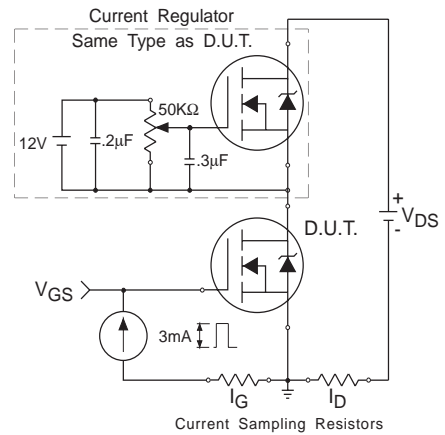


Fig 13b. Gate Charge Test Circuit

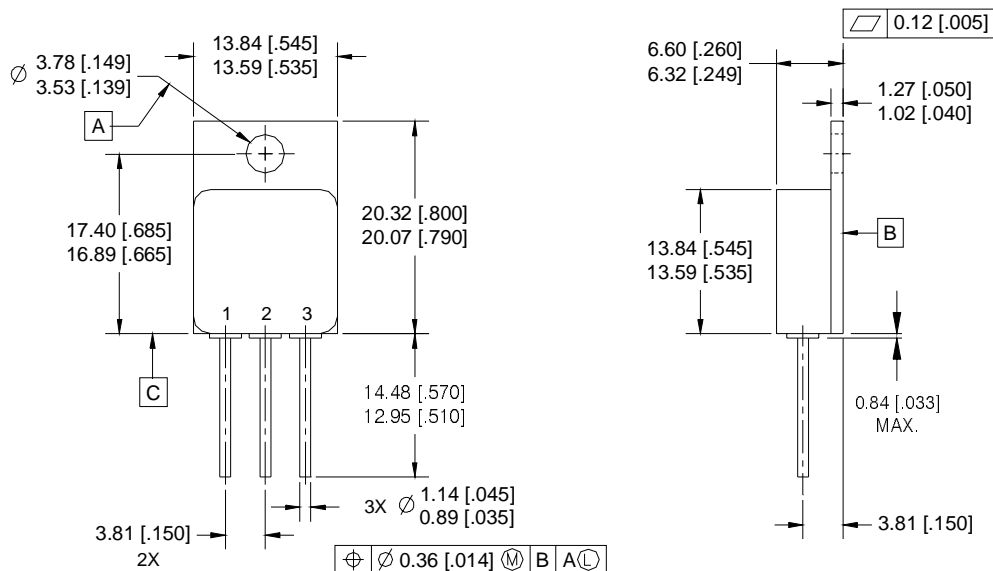
# IRHMS57Z60, JANSR2N7478T1

# Pre-Irradiation

## Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L = 1.1 \text{ mH}$   
Peak  $I_L = 45A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 45A$ ,  $di/dt \leq 150A/\mu s$ ,  
 $V_{DD} \leq 30V$ ,  $T_J \leq 150^\circ C$
- 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.**  
24 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.

International  
**IR** Rectifier

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Visit us at [www.irf.com](http://www.irf.com) for sales contact information.

Data and specifications subject to change without notice. 04/2006