

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

**IRHM7360SE
 JANSR2N7391
 400V, N-CHANNEL
 REF:MIL-PRF-19500/661
 RAD Hard™ HEXFET® TECHNOLOGY**

Product Summary

Part Number	Radiation Level	R _{DS(on)}	I _D	QPL Part Number
IRHM7360SE	100K Rads (Si)	0.20Ω	22A	JANSR2N7391



International Rectifier's RADHard™ HEXFET® MOSFET 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_{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
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Light Weight
- ESD Rating: Class 3B per MIL-STD-750, Method 1020

Absolute Maximum Ratings

Pre-Irradiation

	Parameter		Units
I _D @ V _{GS} = 12V, T _C = 25°C	Continuous Drain Current	22	A
I _D @ V _{GS} = 12V, T _C = 100°C	Continuous Drain Current	14	
I _{DM}	Pulsed Drain Current ①	88	
P _D @ T _C = 25°C	Max. Power Dissipation	250	W
	Linear Derating Factor	2.0	W/°C
V _{GS}	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	500	mJ
I _{AR}	Avalanche Current ①	22	A
EAR	Repetitive Avalanche Energy ①	25	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.0	V/ns
T _J	Operating Junction	-55 to 150	°C
T _{STG}	Storage Temperature Range		
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10 sec.)	
	Weight	9.3 (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
BV _{DSS}	Drain-to-Source Breakdown Voltage	400	—	—	V	V _{GS} = 0V, I _D = 1.0mA
ΔBV _{DSS} /ΔT _J	Temperature Coefficient of Breakdown Voltage	—	0.51	—	V/°C	Reference to 25°C, I _D = 1.0mA
R _{DS(on)}	Static Drain-to-Source On-State Resistance	—	—	0.20	Ω	V _{GS} = 12V, I _D = 14A ④
		—	—	0.21		V _{GS} = 12V, I _D = 22A
V _{GS(th)}	Gate Threshold Voltage	2.5	—	4.5	V	V _{DS} = V _{GS} , I _D = 1.0mA
g _{fs}	Forward Transconductance	6.0	—	—	S	V _{DS} = 15V, I _{DS} = 14A ④
I _{DSS}	Zero Gate Voltage Drain Current	—	—	50	μA	V _{DS} = 320V, V _{GS} = 0V
		—	—	250		V _{DS} = 320V, 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	—	—	185	nC	V _{GS} = 12V, I _D = 22A V _{DS} = 200V
Q _{gs}	Gate-to-Source Charge	—	—	35		
Q _{gd}	Gate-to-Drain ('Miller') Charge	—	—	100		
t _{d(on)}	Turn-On Delay Time	—	—	28	ns	V _{DD} = 200V, I _D = 22A, V _{GS} = 12V, R _G = 2.35Ω
t _r	Rise Time	—	—	97		
t _{d(off)}	Turn-Off Delay Time	—	—	120		
t _f	Fall Time	—	—	72		
L _S + L _D	Total Inductance	—	6.8	—	nH	Measured from drain lead (6mm/0.25in. from package) to source lead (6mm/0.25in. from package)
C _{iss}	Input Capacitance	—	4000	—	pF	V _{GS} = 0V, V _{DS} = 25V f = 1.0MHz
C _{oss}	Output Capacitance	—	1000	—		
C _{rss}	Reverse Transfer Capacitance	—	460	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	22	A	
I _{SM}	Pulse Source Current (Body Diode) ①	—	—	88		
V _{SD}	Diode Forward Voltage	—	—	1.4	V	T _j = 25°C, I _S = 22A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	—	720	ns	T _j = 25°C, I _F = 22A, di/dt ≤ 100A/μs
Q _{RR}	Reverse Recovery Charge	—	—	14	μC	V _{DD} ≤ 50V ④
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L _S + L _D .				

Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R _{thJC}	Junction-to-Case	—	—	0.50	°C/W	Typical socket mount
R _{thCS}	Case-to-Sink	—	0.21	—		
R _{thJA}	Junction-to-Ambient	—	—	48		

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

For footnotes refer to the last page

Pre-Irradiation

IRHM7360SE, JANSR2N7391

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	100KRads (Si)		Units	Test Conditions
		Min	Max		
BV _{DSS}	Drain-to-Source Breakdown Voltage	400	—	V	V _{GS} = 0V, I _D = 1.0mA
V _{GS(th)}	Gate Threshold Voltage	2.0	4.5		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	—	50	μA	V _{DS} = 320V, V _{GS} = 0V
R _{DS(on)}	Static Drain-to-Source On-State Resistance (TO-3) ④	—	0.20	Ω	V _{GS} = 12V, I _D = 14A
R _{DS(on)}	Static Drain-to-Source On-State Resistance (TO-254) ④	—	0.20	Ω	V _{GS} = 12V, I _D = 14A
V _{SD}	Diode Forward Voltage ④	—	1.4	V	V _{GS} = 0V, I _D = 22A

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

Ion	LET MeV/(mg/cm ²)	Energy (MeV)	Range (μm)	V _{DS} (V)					
				@V _{GS} =0V	@V _{GS} =-5V	@V _{GS} =-10V	@V _{GS} =-15V	@V _{GS} =-20V	@V _{GS} =-25V
Cu	28	285	43	325	325	325	325	325	325
Br	36.8	305	39	325	325	325	325	320	—

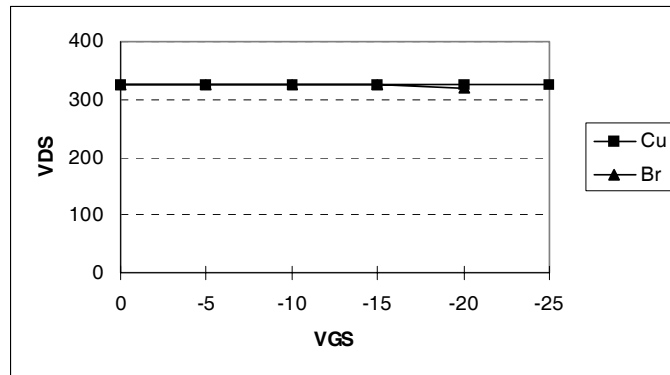


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the last page

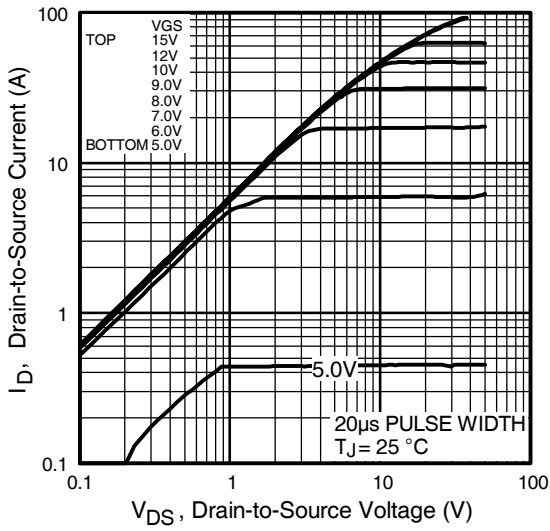


Fig 1. Typical Output Characteristics

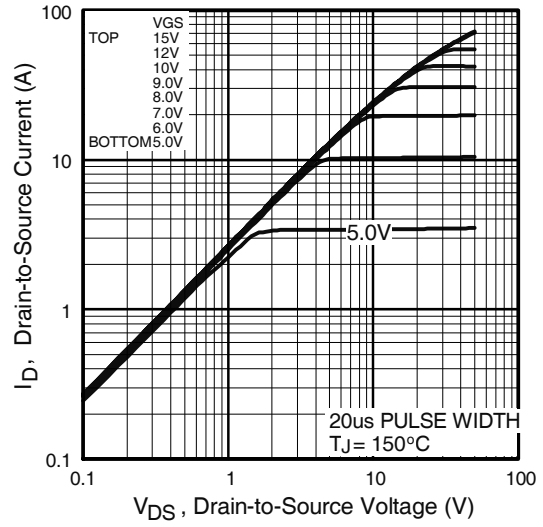


Fig 2. Typical Output Characteristics

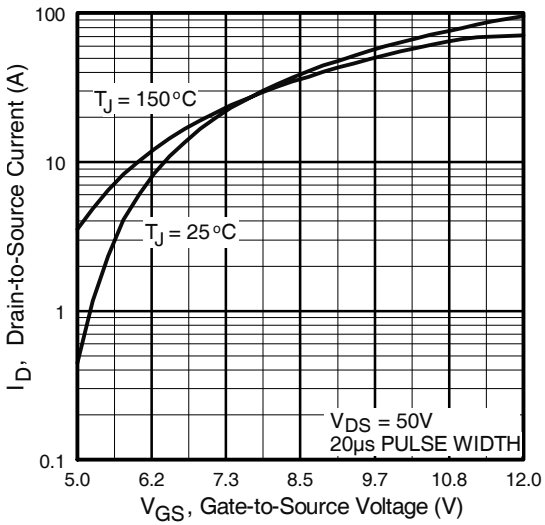


Fig 3. Typical Transfer Characteristics

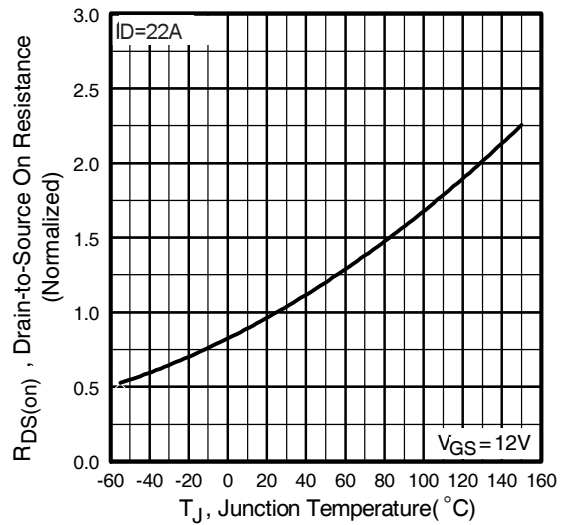


Fig 4. Normalized On-Resistance Vs. Temperature

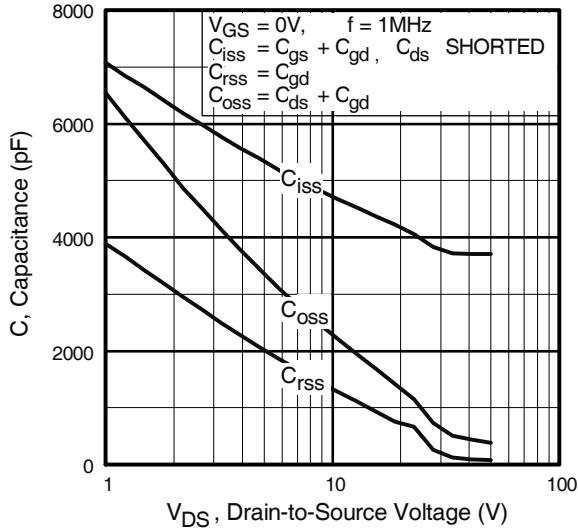


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

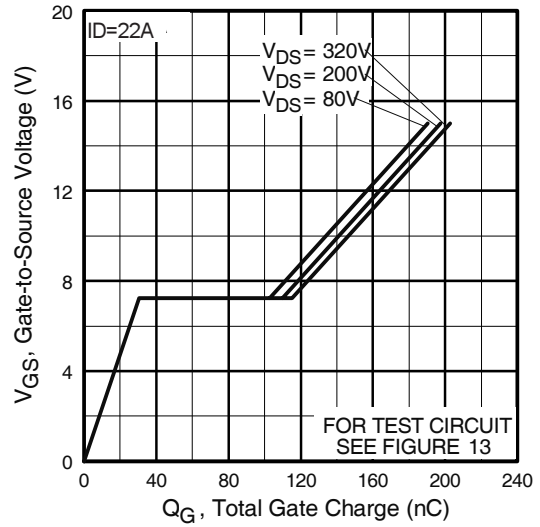


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

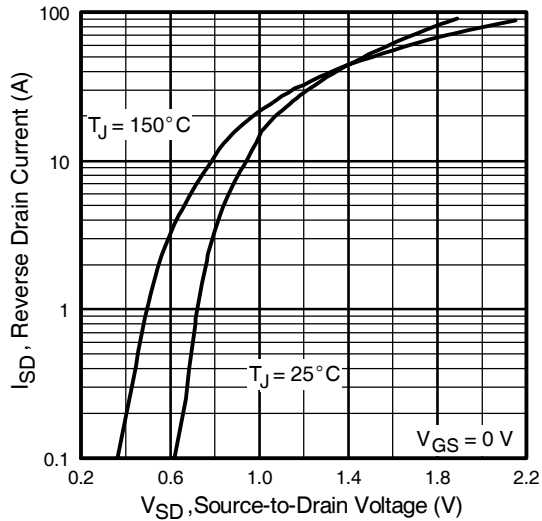


Fig 7. Typical Source-Drain Diode Forward Voltage

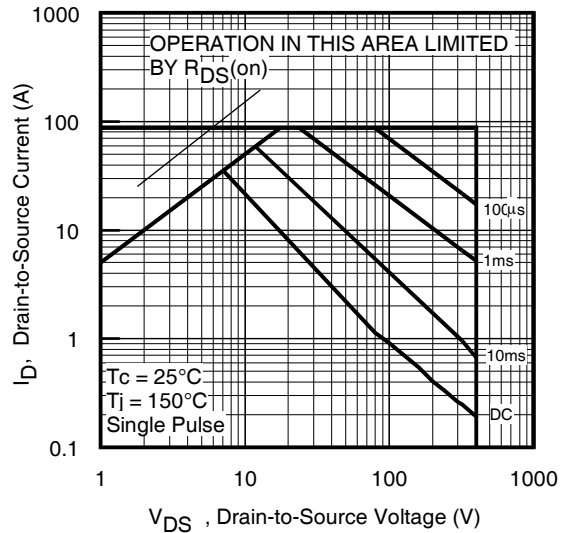


Fig 8. Maximum Safe Operating Area

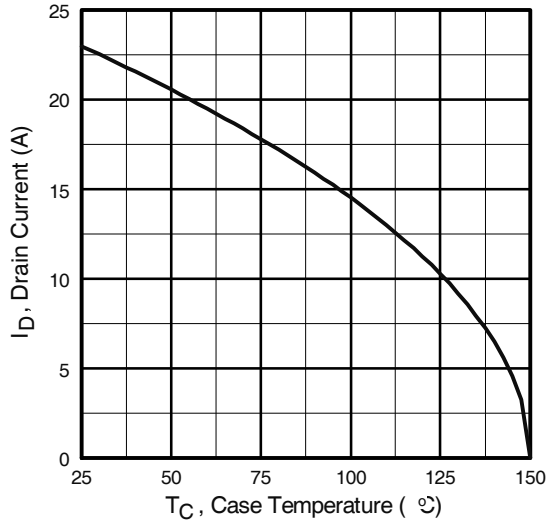


Fig 9. Maximum Drain Current Vs. Case Temperature

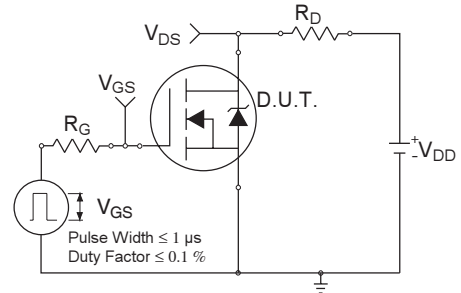


Fig 10a. Switching Time Test Circuit

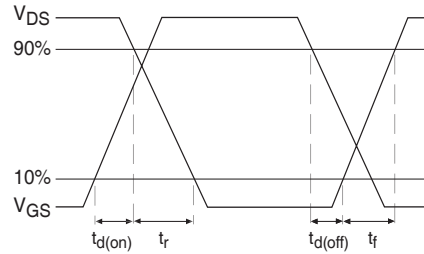


Fig 10b. Switching Time Waveforms

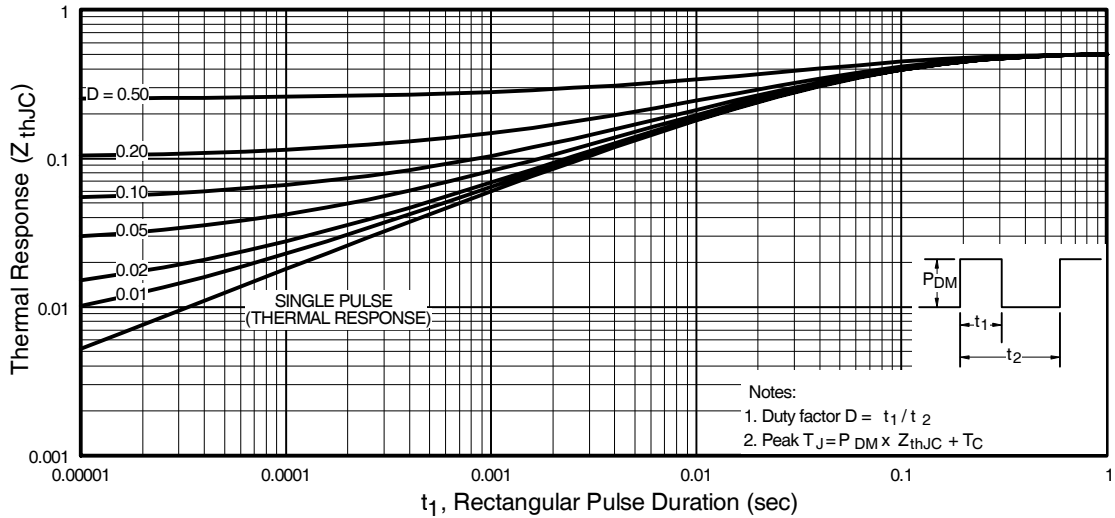


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

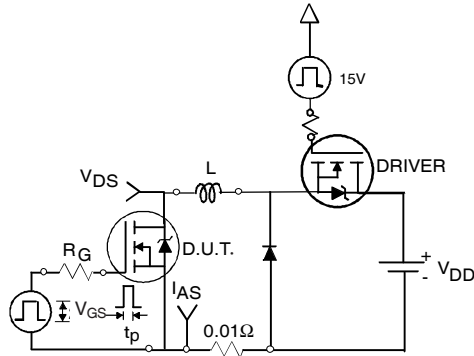


Fig 12a. Unclamped Inductive Test Circuit



Fig 12b. Unclamped Inductive Waveforms

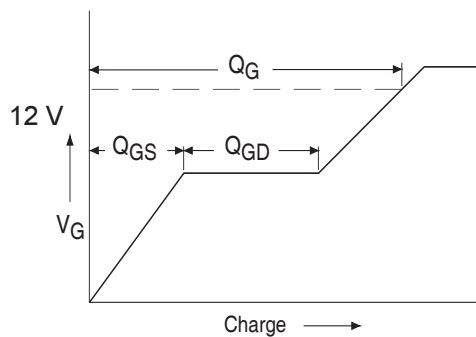


Fig 13a. Basic Gate Charge Waveform

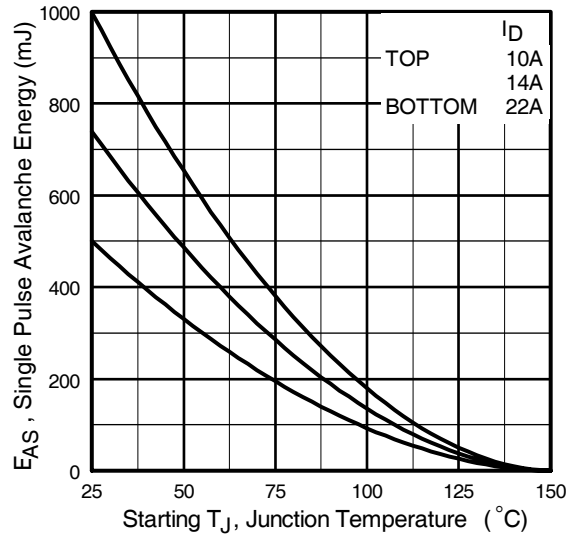


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

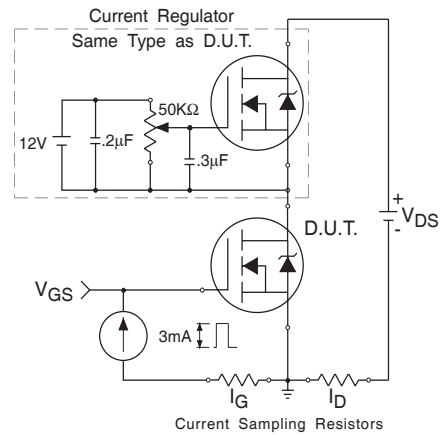
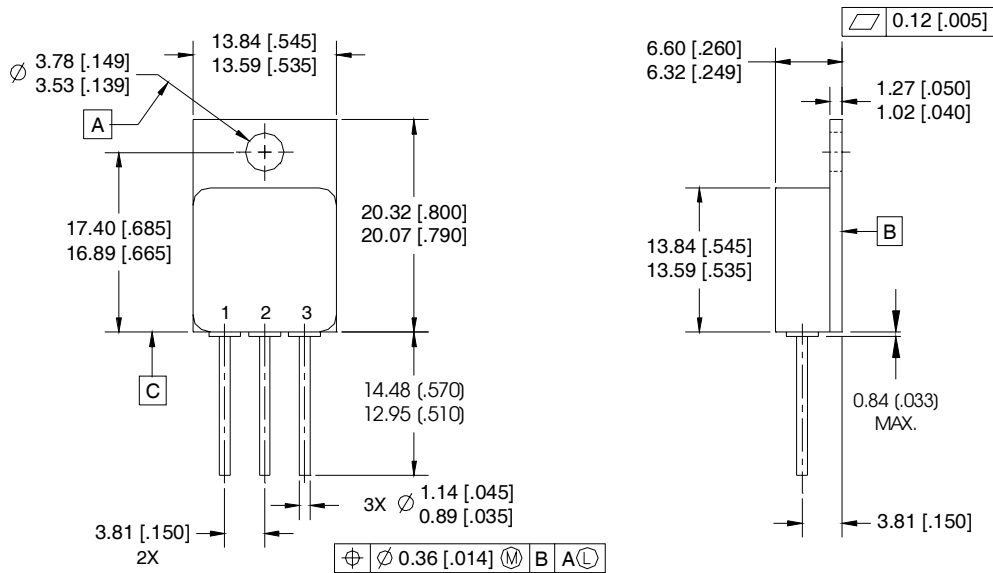


Fig 13b. Gate Charge Test Circuit

Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② $V_{DD} = 50V$, starting $T_J = 25^\circ C$, $L = 2.0\text{ mH}$
Peak $I_L = 22A$, $V_{GS} = 12V$
- ③ $I_{SD} \leq 22A$, $di/dt \leq 120A/\mu s$,
 $V_{DD} \leq 400V$, $T_J \leq 150^\circ C$
- 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.**
320 volt V_{DS} applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, method 1019, condition A.

Case Outline and Dimensions —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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