International Rectifier

IRHM7054
JANSR2N7394
60V, N-CHANNEL
REF: MIL-PRF-19500/603
RAD-Hard™ HEXFET® TECHNOLOGY

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

Product Summary

Part Number	Radiation Level	$R_{DS(on)}$	I_D	QPL Part Number
IRHM7054	100K Rads (Si)	0.027Ω	35A*	JANSR2N7394
IRHM3054	300K Rads (Si)	0.027Ω	35A*	JANSF2N7394
IRHM4054	500K Rads (Si)	0.027Ω	35A*	JANSG2N7394
IRHM8054	1000K Rads (Si)	0.040Ω	35A*	JANSH2N7394

TO-254AA

International Rectifier's RAD-Hard™ 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 Rdson 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 $R_{DS(on)}$
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Package
- Light Weight

Absolute Maximum Ratings

Pre-Irradiation

	Parameter		Units
I_D @ V_{GS} = 12V, T_C = 25°C	Continuous Drain Current	35*	A
I_D @ V_{GS} = 12V, T_C = 100°C	Continuous Drain Current	30	
I_{DM}	Pulsed Drain Current ①	140	
P_D @ T_C = 25°C	Max. Power Dissipation	150	W
	Linear Derating Factor	1.2	W/°C
V_{GS}	Gate-to-Source Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	500	mJ
I_{AR}	Avalanche Current ①	35	A
E_{AR}	Repetitive Avalanche Energy ①	15	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.5	V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	-55 to 150	°C
	Lead Temperature	300 (0.063 in.(1.6mm) from case for 10s)	
	Weight	9.3 (Typical)	g

*Current is limited by package
For footnotes refer to the last page

05/15/06

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

	Parameter	Min	Typ	Max	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	—	—	V	V_{GS} = 0V, I_D = 1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.053	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.027	Ω	V_{GS} = 12V, I_D = 30A ④
		—	—	0.030		V_{GS} = 12V, I_D = 35A
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	V_{DS} = V_{GS}, I_D = 1.0mA
g_{fs}	Forward Transconductance	12	—	—	S (℧)	V_{DS} > 15V, I_{DS} = 30A ④
I_{DSS}	Zero Gate Voltage Drain Current	—	—	25	µA	V_{DS}= 48V ,V_{GS}=0V
		—	—	250		V_{DS} = 48V, 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	—	—	200	nC	V_{GS} =12V, I_D = 35A
Q_{gs}	Gate-to-Source Charge	—	—	60		V_{DS} = 30V
Q_{gd}	Gate-to-Drain ('Miller') Charge	—	—	75		
$t_{d(on)}$	Turn-On Delay Time	—	—	27	ns	V_{DD} =30V, I_D = 35A
t_r	Rise Time	—	—	100		V_{GS} =12V, R_G = 2.35Ω
$t_{d(off)}$	Turn-Off Delay Time	—	—	75		
t_f	Fall Time	—	—	75		
$L_S + L_D$	Total Inductance	—	6.8	—	nH	Measured from Drain lead (6mm /0.25in from package) to Source lead (6mm /0.25in. from Package) with Source wires internally bonded from Source Pin to Drain Pad
C_{iss}	Input Capacitance	—	4100	—	pF	V_{GS} = 0V, V_{DS} = 25V
C_{oss}	Output Capacitance	—	2000	—		f = 1.0MHz
C_{rss}	Reverse Transfer Capacitance	—	560	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	—	—	35*	A	
I_{SM}	Pulse Source Current (Body Diode) ①	—	—	140		
V_{SD}	Diode Forward Voltage	—	—	1.4	V	T_j = 25°C, I_S = 35A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	280	ns	T_j = 25°C, I_F = 35A, di/dt ≤ 100A/µs
Q_{RR}	Reverse Recovery Charge	—	—	2.2	µC	V_{DD} ≤ 50V ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.				

* Current is limited by package

Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R_{thJC}	Junction-to-Case	—	—	0.83	°C/W	
R_{thJA}	Junction-to-Ambient	—	—	48		Typical socket mount
R_{thCS}	Case-to-Sink	—	0.21	—		

Note: Corresponding Spice and Saber models are available on International Rectifier Website.
For footnotes refer to the last page

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)[1]		1000K Rads (Si)[2]		Units	Test Conditions
		Min	Max	Min	Max		
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	—	60	—	V	V_{GS} = 0V, I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	1.25	4.5		V_{GS} = V_{DS}, I_D = 1.0mA
I_{GSS}	Gate-to-Source Leakage Forward	—	100	—	100	nA	V_{GS} = 20V
I_{GSS}	Gate-to-Source Leakage Reverse	—	-100	—	-100		V_{GS} = -20 V
I_{DSS}	Zero Gate Voltage Drain Current	—	25	—	50	µA	V_{DS}= 48V, V_{GS} = 0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.027	—	0.04	Ω	V_{GS} = 12V, I_D = 30A
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-254AA)	—	0.027	—	0.04	Ω	V_{GS} = 12V, I_D = 30A
V_{SD}	Diode Forward Voltage ④	—	1.4	—	1.4	V	V_{GS} = 0V, I_S = 35A

1. Part numbers IRHM7054 (JANSR2N7394), IRHM3054 (JANSF2N7394), IRHM4054 (JANSG2N7394)
2. Part number IRHM8054 (JANSH2N7394)

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	Energy	Range	V_{DS} (V)				
	(MeV/(mg/cm²))	(MeV)	(µm)	@V_{GS}=0V	@V_{GS}=-5V	@V_{GS}=-10V	@V_{GS}=-15V	@V_{GS}=-20V
Br	36.8	305	39	60	60	45	40	30
I	59.9	345	32.8	40	35	30	25	20

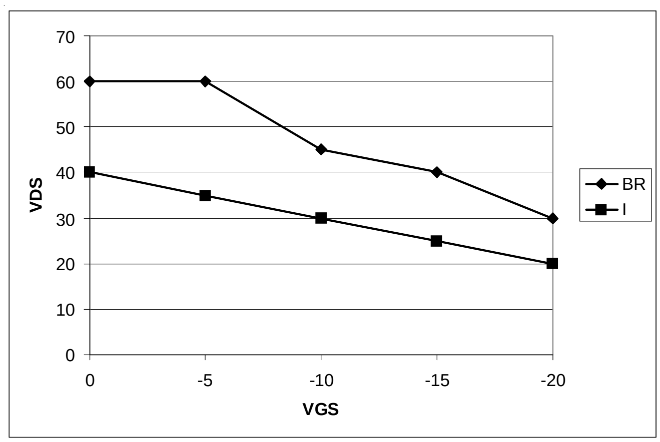


Fig a. Single Event Effect, Safe Operating Area

For footnotes refer to the last page

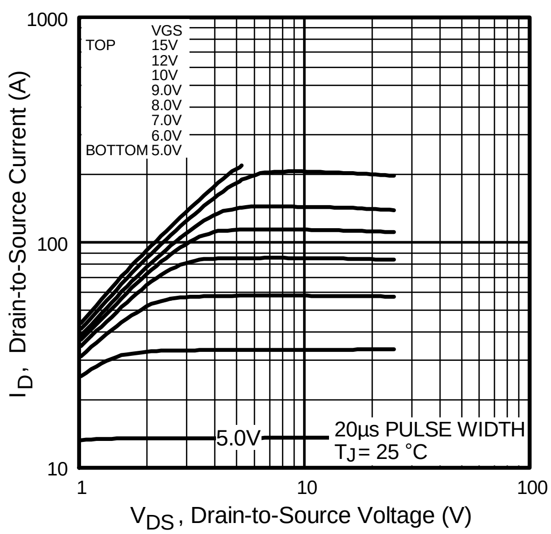


Fig 1. Typical Output Characteristics

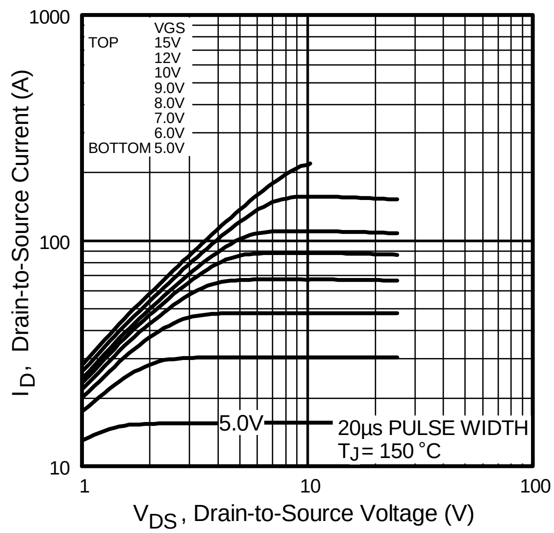


Fig 2. Typical Output Characteristics

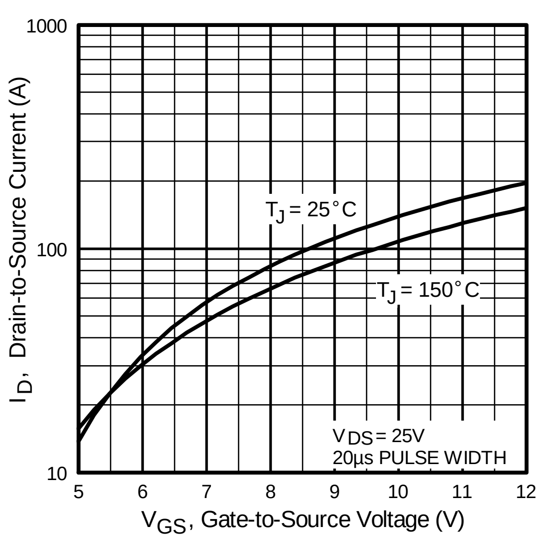


Fig 3. Typical Transfer Characteristics

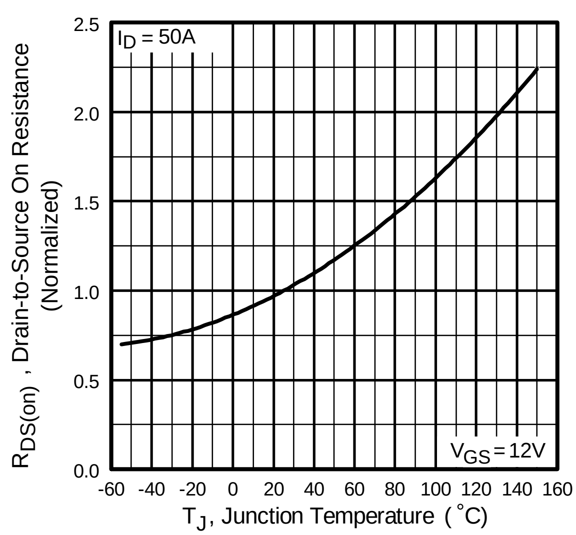


Fig 4. Normalized On-Resistance Vs. Temperature

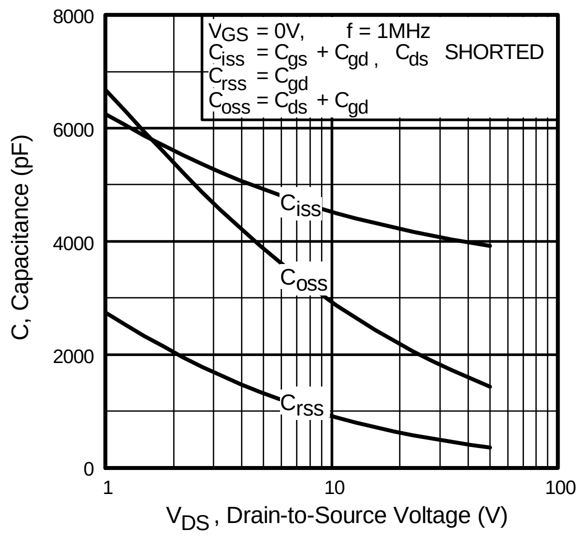


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

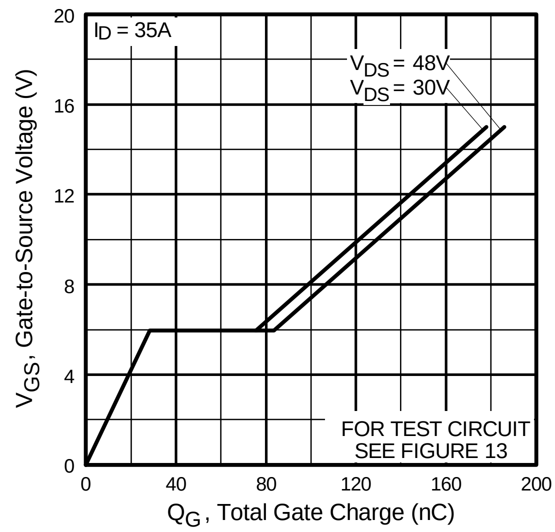


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

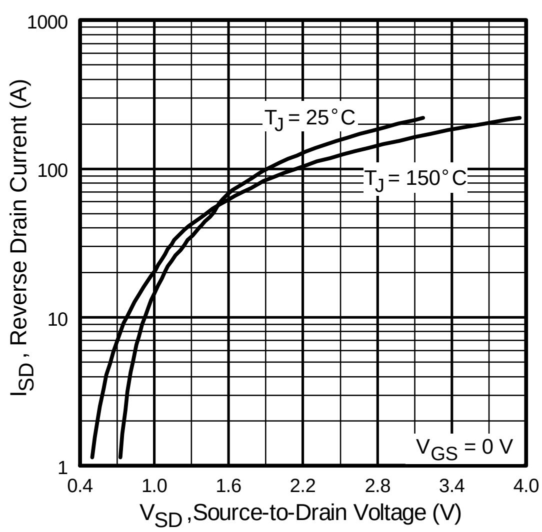


Fig 7. Typical Source-Drain Diode Forward Voltage

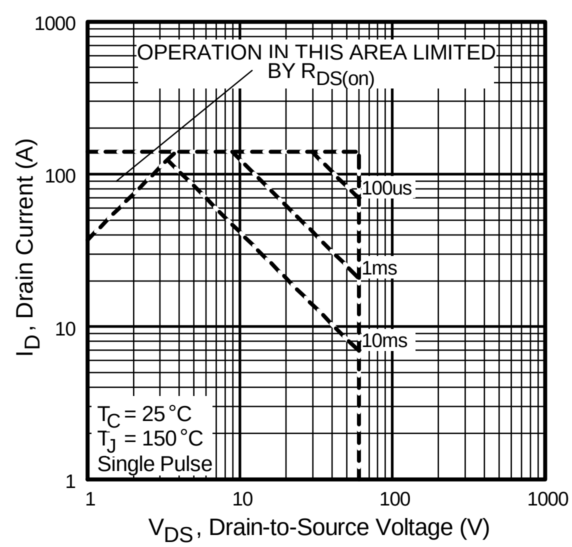


Fig 8. Maximum Safe Operating Area

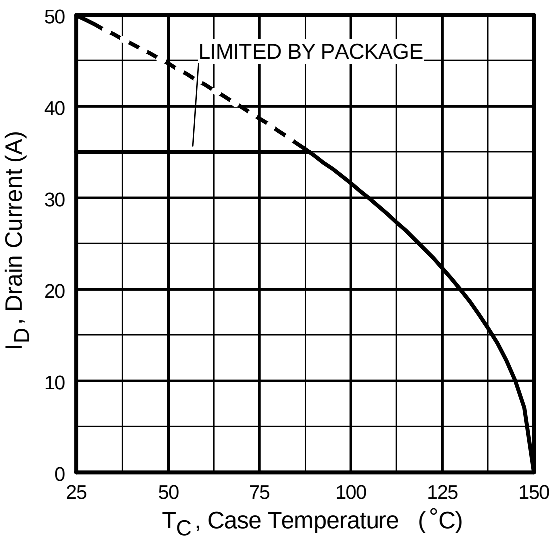


Fig 9. Maximum Drain Current Vs. Case Temperature

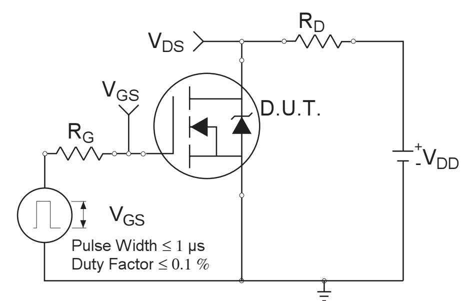


Fig 10a. Switching Time Test Circuit

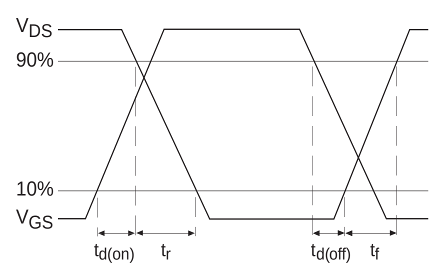


Fig 10b. Switching Time Waveforms

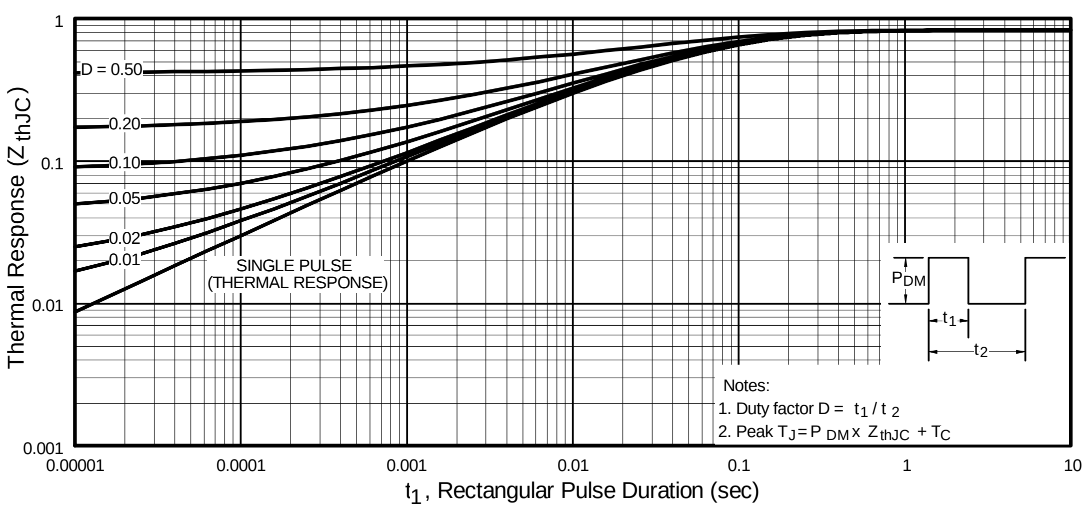


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

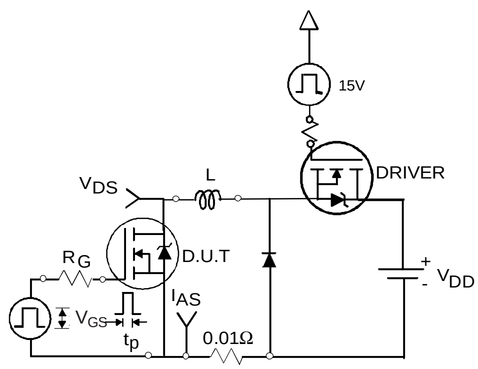


Fig 12a. Unclamped Inductive Test Circuit

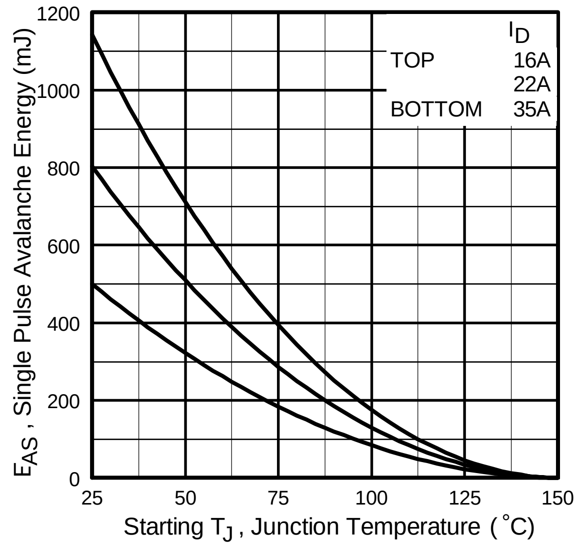


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

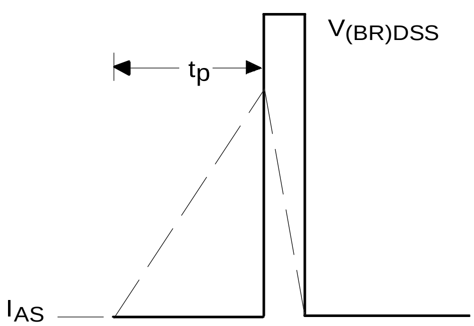


Fig 12b. Unclamped Inductive Waveforms

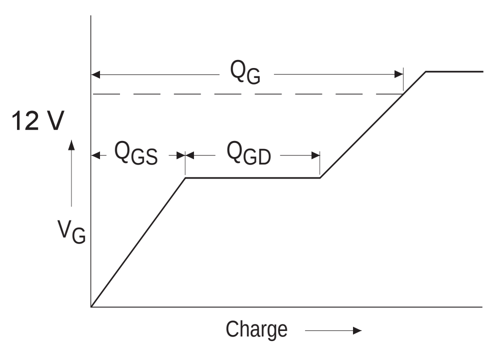


Fig 13a. Basic Gate Charge Waveform

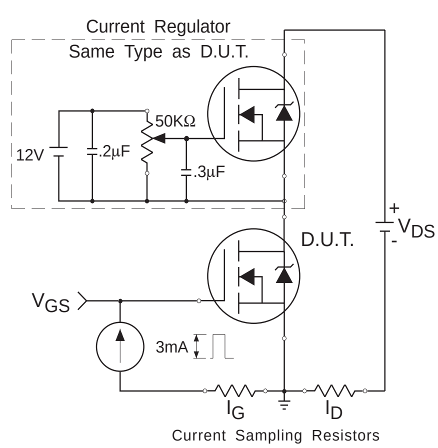
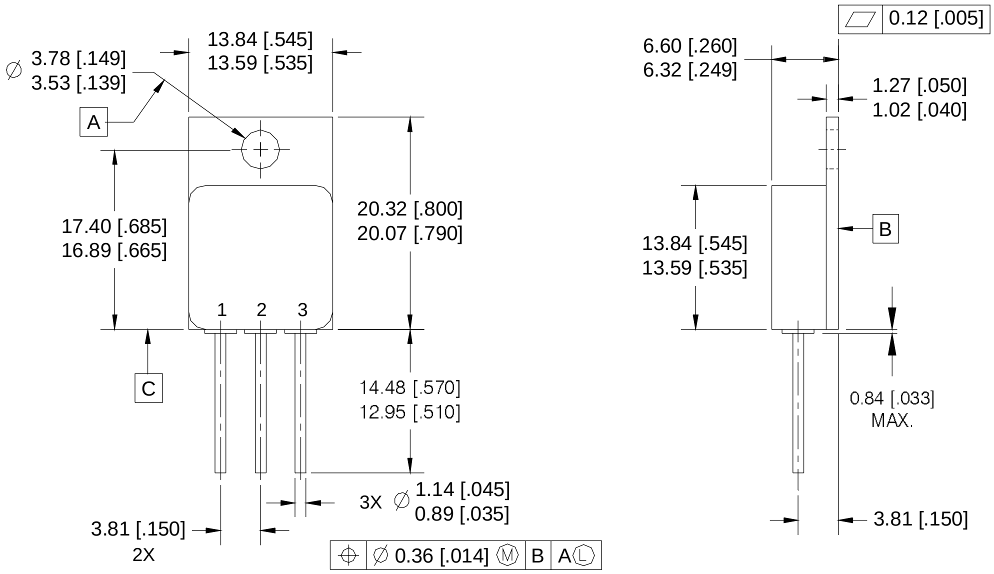


Fig 13b. Gate Charge Test Circuit

Foot Notes:

① Repetitive Rating; Pulse width limited by maximum junction temperature.
② V_{DD} = 25V, starting T_J = 25°C, L= 0.9mH Peak I_L = 35A, V_{GS} =12V
③ $I_{SD} \leq$ 35A, di/dt ≤ 150A/μs, $V_{DD} \leq$ 60V, $T_J \leq$ 150°C
④ Pulse width ≤ 300 μs; Duty Cycle ≤ 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.** 48 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.

International
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