

# International IOR Rectifier

## RADIATION HARDENED POWER MOSFET THRU-HOLE (T0-204AA/AE)

## IRH7054 60V, N-CHANNEL RAD Hard™ HEXFET® TECHNOLOGY

### Product Summary

Part Number	Radiation Level	RDS(on)	ID
IRH7054	100K Rads (Si)	0.025Ω	45*A
IRH3054	300K Rads (Si)	0.025Ω	45*A
IRH4054	600K Rads (Si)	0.025Ω	45*A
IRH8054	1000K Rads (Si)	0.025Ω	45*A



International Rectifier's RADHard 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 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:

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Package
- 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	32	
IDM	Pulsed Drain Current ①	210	
PD @ TC = 25°C	Max. Power Dissipation	150	W
	Linear Derating Factor	1.2	W/°C
VGS	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	500	mJ
IAR	Avalanche Current ①	35	A
EAR	Repetitive Avalanche Energy ①	15	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.5	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	Lead Temperature	300 ( 0.063 in.(1.6mm) from case for 10s)	
	Weight	11.5 (Typical)	g



Electrical Characteristics @ T<sub>j</sub> = 25°C (Unless Otherwise Specified)

	Parameter	Min	Typ	Max	Units	Test Conditions
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	60	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.053	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.025	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 32A ④
		—	—	0.028		
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	12	—	—	S (Ω)	V <sub>DS</sub> > 15V, I <sub>DS</sub> = 35A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	25	μA	V <sub>DS</sub> = 48V, V <sub>GS</sub> = 0V
		—	—	250		
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	—	—	200	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 35A V <sub>DS</sub> = 30V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	60		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	75		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	27		
t <sub>r</sub>	Rise Time	—	—	100	ns	V <sub>DD</sub> = 30V, I <sub>D</sub> = 35A 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	—	—	75		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	10	—	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	—	4100	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	2000	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	560	—		

## 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> = 35A, V <sub>GS</sub> = 0V ④
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	210		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.4	V	T <sub>j</sub> = 25°C, I <sub>F</sub> = 35A, di/dt ≤ 100A/μs V <sub>DD</sub> ≤ 50V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	280	nS	
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	2.2	μC	
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> .				

## Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	0.83	°C/W	Typical socket mount
R <sub>thJA</sub>	Junction-to-Ambient	—	—	30		
R <sub>thCS</sub>	Case-to-Sink	—	0.12	—		

Note: Corresponding Spice and Saber models are available on the G&S Website.

For footnotes refer to the last page

## Radiation Characteristics

IRH7054

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	100K Rads (Si) <sup>1</sup>	300 - 1000K Rads (Si) <sup>2</sup>	Units		Test Conditions		
			Min	Max			
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	60	—	60	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	4.0	1.25	4.5		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	—	25	—	50	μA	V <sub>DS</sub> =48V, V <sub>GS</sub> =0V
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance (TO-3)	—	0.027	—	0.027	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> =45A
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance (TO-204AE)	—	0.027	—	0.027	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> =45A
V <sub>SD</sub>	Diode Forward Voltage	—	1.4	—	1.4	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 35A

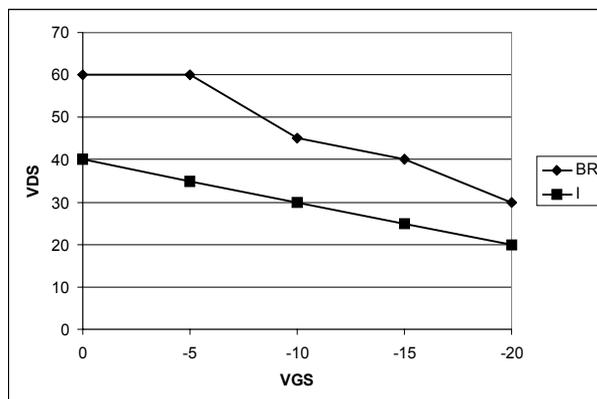
1. Part numbers IRH7054,

2. Part number IRH3054, IRH4540 and IRH8054

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
I	59.9	345	32.8	60	60	45	40	30
Br	36.8	305	39	40	35	30	25	20



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

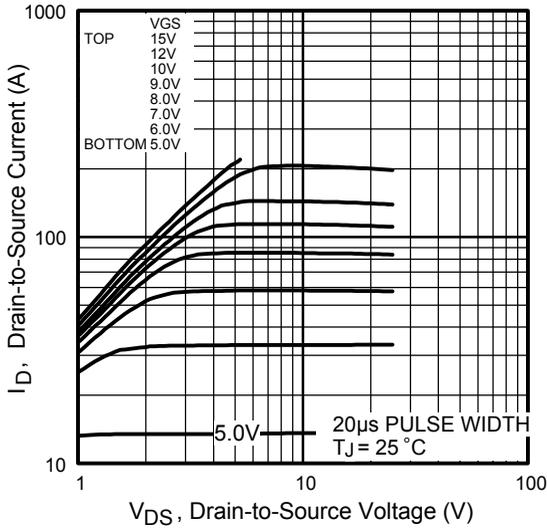


Fig 1. Typical Output Characteristics

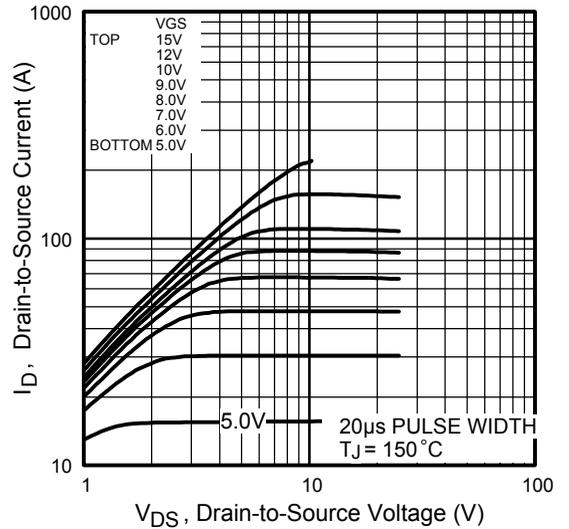


Fig 2. Typical Output Characteristics

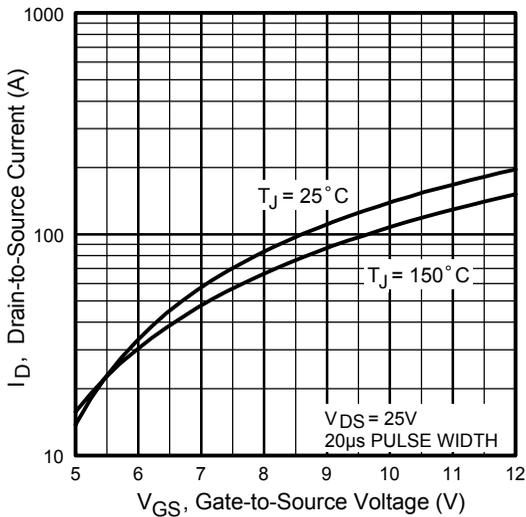


Fig 3. Typical Transfer Characteristics

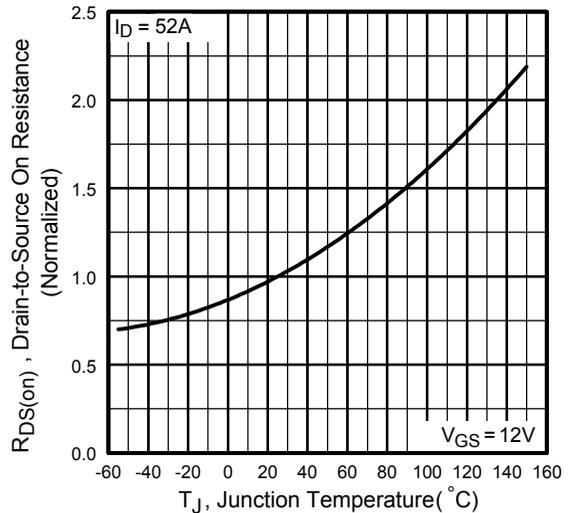
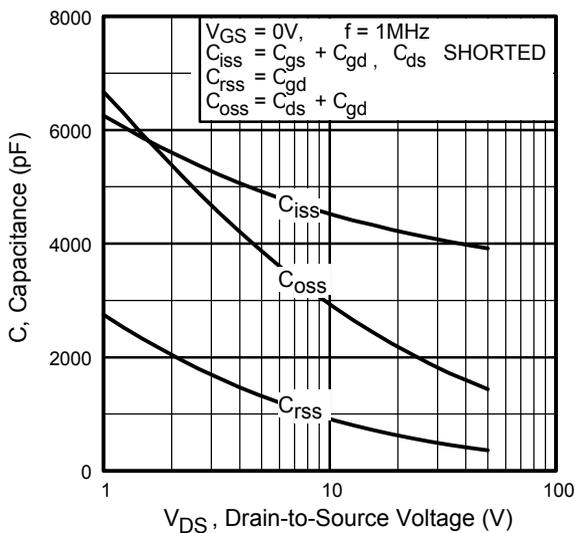
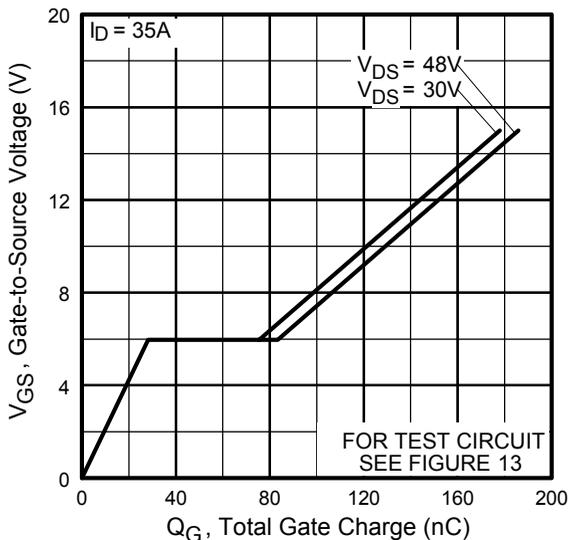


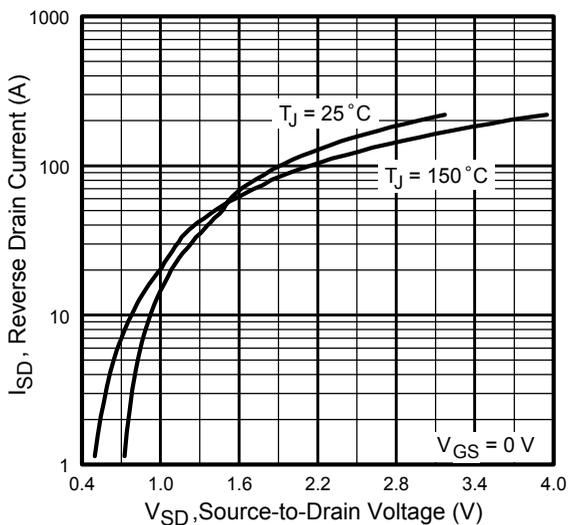
Fig 4. Normalized On-Resistance Vs. Temperature



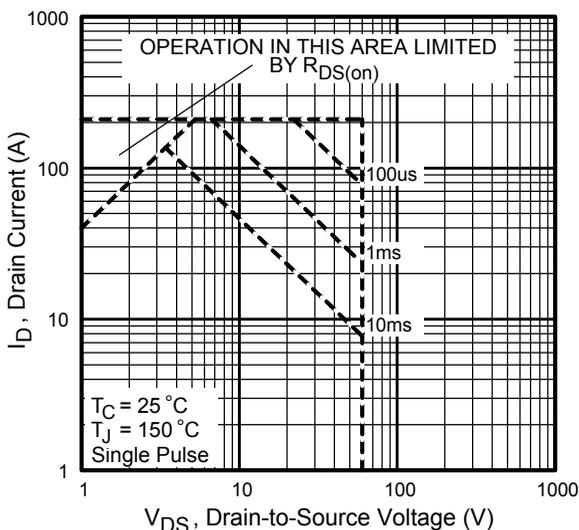
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



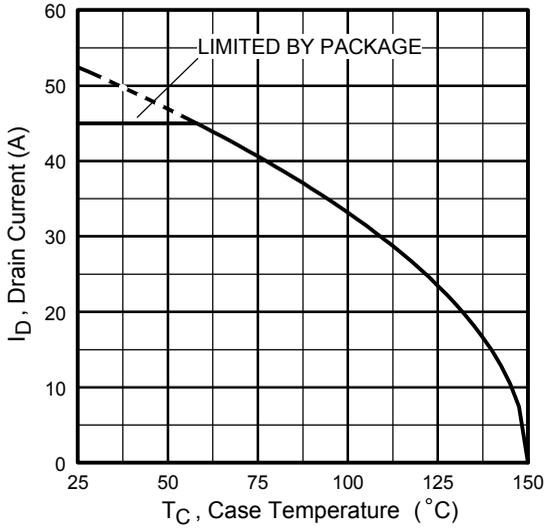
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



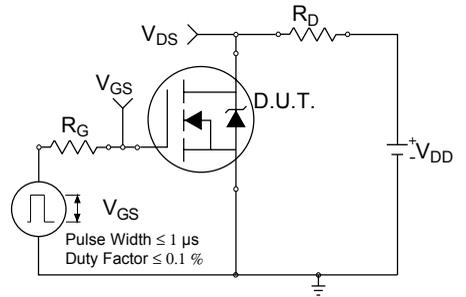
**Fig 7.** Typical Source-Drain Diode Forward Voltage



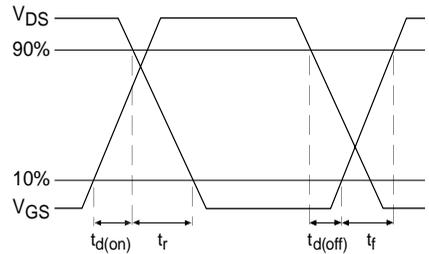
**Fig 8.** Maximum Safe Operating Area



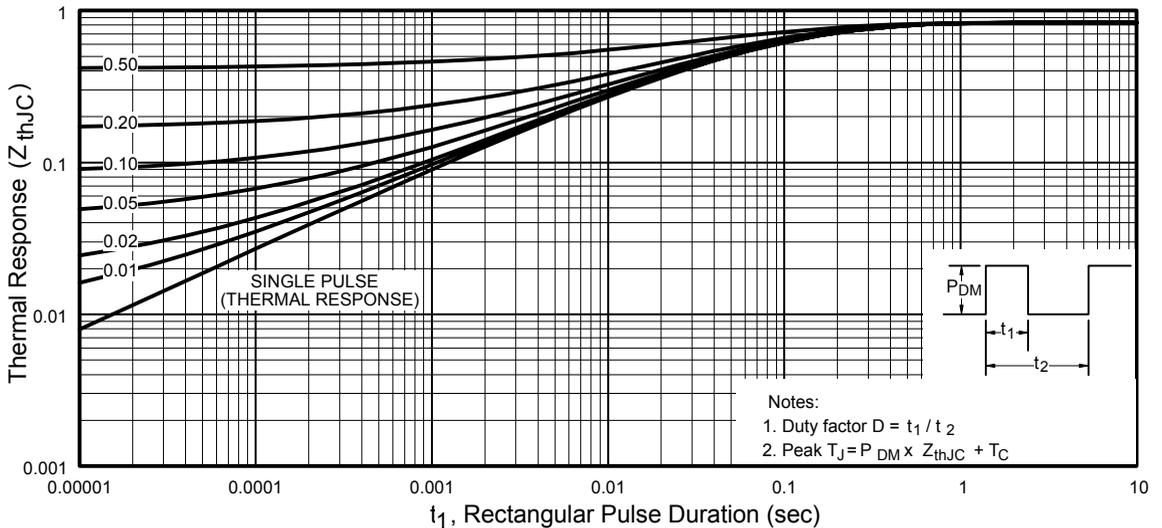
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



**Fig 10b.** Switching Time Waveforms



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

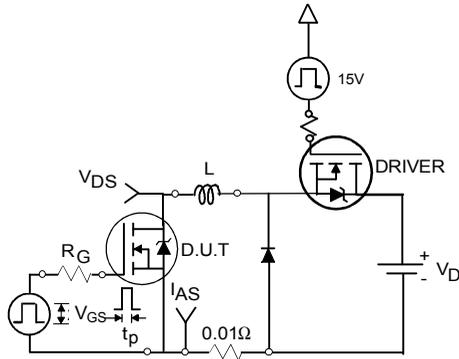


Fig 12a. Unclamped Inductive Test Circuit

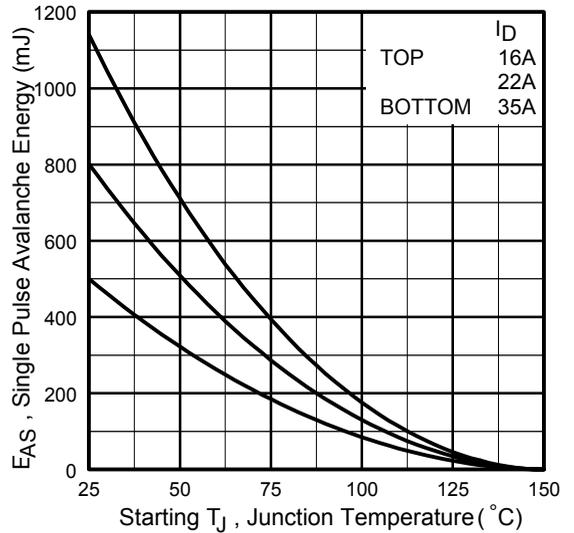


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

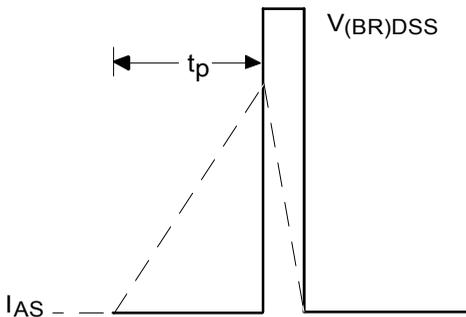


Fig 12b. Unclamped Inductive Waveforms

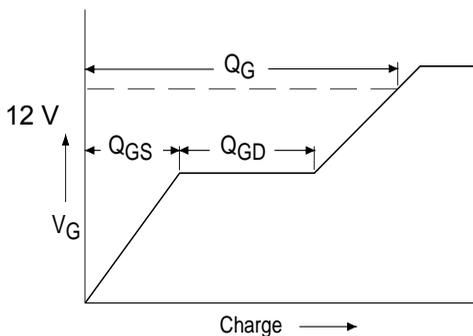


Fig 13a. Basic Gate Charge Waveform

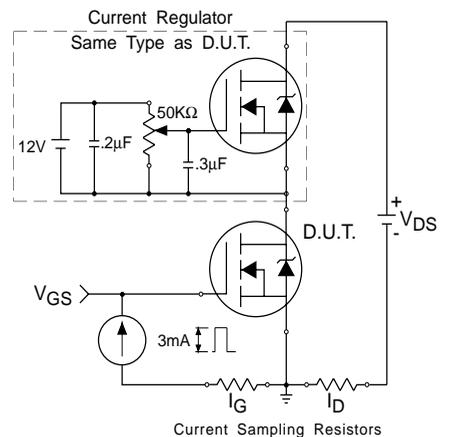
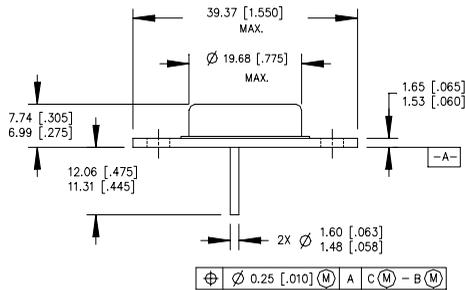


Fig 13b. Gate Charge Test Circuit

Foot Notes:

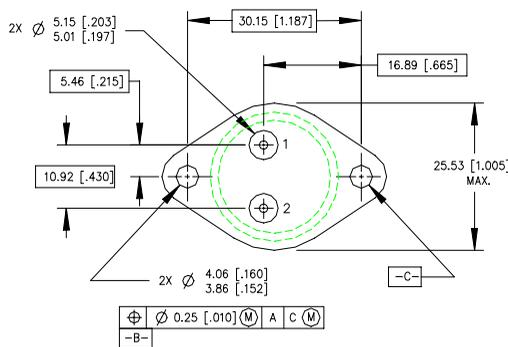
- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L=0.49mH$   
Peak  $I_L = 35A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 35A$ ,  $di/dt \leq 150A/\mu s$ ,  
 $V_{DD} \leq 60V$ ,  $T_J \leq 150^\circ C$
- ④ Pulse width  $\leq 300 \mu s$ ; 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.**  
48 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

Case Outline and Dimensions — TO-204AE



PIN ASSIGNMENTS

- 1 - SOURCE
- 2 - GATE
- 3 - DRAIN (CASE)



NOTES:

1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE TO-204AE.

