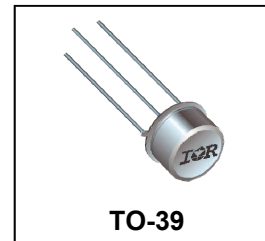


**RADIATION HARDENED
POWER MOSFET
THRU-HOLE (TO-39)**

**200V, N-CANNEL
R₆ TECHNOLOGY**

Product Summary

Part Number	Radiation Level	RDS(on)	I _D
IRHF6S7230	100 kRads(Si)	0.145Ω	9.1A
IRHF6S3230	300 kRads(Si)	0.145Ω	9.1A



Description

IR HiRel R6 S-line technology provides high performance power MOSFETs for space applications. These devices have been characterized for both Total Dose and Single Event Effect (SEE) with useful performance up to LET of 60 (MeV/cm²). The combination of low RDS(on) and low gate charge reduces the power losses in 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, fast switching and temperature stability of electrical parameters.

Features

- Low RDS(on)
- Fast Switching
- Single Event Effect (SEE) Hardened
- Low Total Gate Charge
- Simple Drive Requirements
- Hermetically Sealed
- ESD Rating: Class 3A per MIL-STD-750, Method 1020

Absolute Maximum Ratings

Pre-Irradiation

	Parameter		Units
I _{D1} @ V _{GS} = 12V, T _C = 25°C	Continuous Drain Current	9.1	A
I _{D2} @ V _{GS} = 12V, T _C = 100°C	Continuous Drain Current	5.7	
I _{DM} @ T _C = 25°C	Pulsed Drain Current ①	36.4	
P _D @ T _C = 25°C	Maximum Power Dissipation	25	W
	Linear Derating Factor	0.2	W/°C
V _{GS}	Gate-to-Source Voltage	± 20	V
E _{AS}	Single Pulse Avalanche Energy ②	23	mJ
I _{AR}	Avalanche Current ①	9.1	A
E _{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.8	V/ns
T _J T _{STG}	Operating Junction and Storage Temperature Range	-55 to + 150	°C
	Lead Temperature	300 (0.063 in. /1.6 mm from case for 10s)	
	Weight	0.98 (Typical)	

For footnotes refer to the page 2.

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

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV _{DSS}	Drain-to-Source Breakdown Voltage	200	—	—	V	V _{GS} = 0V, I _D = 1.0mA
ΔBV _{DSS} /ΔT _J	Breakdown Voltage Temp. Coefficient	—	0.22	—	V/°C	Reference to 25°C, I _D = 1.0mA
R _{DS(on)}	Static Drain-to-Source On-Resistance	—	—	0.145	Ω	V _{GS} = 12V, I _{D2} = 5.7A ④
V _{GS(th)}	Gate Threshold Voltage	2.0	—	4.0	V	V _{DS} = V _{GS} , I _D = 1.0mA
ΔV _{GS(th)} /ΔT _J	Gate Threshold Voltage Coefficient	—	-9.76	—	mV/°C	
g _{fs}	Forward Transconductance	5.0	—	—	S	V _{DS} = 15V, I _{D2} = 5.7A 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
	Gate-to-Source Leakage Reverse	—	—	-100		V _{GS} = -20V
Q _G	Total Gate Charge	—	—	45	nC	I _{D1} = 9.1A
Q _{GS}	Gate-to-Source Charge	—	—	12		V _{DS} = 100V
Q _{GD}	Gate-to-Drain ('Miller') Charge	—	—	30		V _{GS} = 12V
t _{d(on)}	Turn-On Delay Time	—	—	17	ns	V _{DD} = 100V
t _r	Rise Time	—	—	30		I _{D1} = 9.1A
t _{d(off)}	Turn-Off Delay Time	—	—	40		R _G = 7.5Ω
t _f	Fall Time	—	—	25		V _{GS} = 12V
L _S + L _D	Total Inductance	—	7.0	—	nH	Measured from Drain lead (6mm / 0.25 in from package) to Source lead (6mm / 0.25 in from package) with Source wire internally bonded from Source pin to Drain pad
C _{ISS}	Input Capacitance	—	1374	—	pF	V _{GS} = 0V
C _{OSS}	Output Capacitance	—	214	—		V _{DS} = 25V
C _{RSS}	Reverse Transfer Capacitance	—	4.2	—		f = 1.0MHz
R _G	Gate Resistance	—	1.1	—	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)	—	—	9.1	A	
I _{SM}	Pulsed Source Current (Body Diode) ①	—	—	36.4		
V _{SD}	Diode Forward Voltage	—	—	1.2	V	T _J = 25°C, I _S = 9.1A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	—	317	ns	T _J = 25°C, I _F = 9.1A, V _{DD} ≤ 50V di/dt = 100A/μs ④
Q _{rr}	Reverse Recovery Charge	—	—	2.91	μC	
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L _S +L _D)				

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
R _{θJC}	Junction-to-Case	—	—	5.0	°C/W

Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② V_{DD} = 50V, starting T_J = 25°C, L = 0.56mH, Peak I_L = 9.1A, V_{GS} = 12V
- ③ I_{SD} ≤ 9.1A, di/dt ≤ 347A/μs, V_{DD} ≤ 200V, T_J ≤ 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. 160 volt V_{DS} applied and V_{GS} = 0 during irradiation per MIL-STD-750, Method 1019, condition A.

Radiation Characteristics

IR HiRel 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.

Table1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation ⑤⑥

	Parameter	Up to 300 kRads(Si) ¹		Units	Test Conditions
		Min.	Max.		
BV _{DSS}	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	V _{DS} = V _{GS} , I _D = 1.0mA
I _{GSS}	Gate-to-Source Leakage Forward	—	100	nA	V _{GS} = 20V
I _{GSS}	Gate-to-Source Leakage Reverse	—	-100	nA	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 On-State ^④ Resistance (TO-3)	—	0.145	Ω	V _{GS} = 12V, I _{D2} = 5.7A
R _{DS(on)}	Static Drain-to-Source On--State ^④ Resistance (TO-39)	—	0.145	Ω	V _{GS} = 12V, I _{D2} = 5.7A
V _{SD}	Diode Forward Voltage	—	1.2	V	V _{GS} = 0V, I _S = 9.1A

1. Part numbers IRHF6S7230 and IRHF6S3230

IR HiRel 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
49.2 ± 5%	719 ± 5%	64.2 ± 5%	200	200	200	200
58.4 ± 5%	876 ± 5%	69.7 ± 7.5%	180	180	180	—

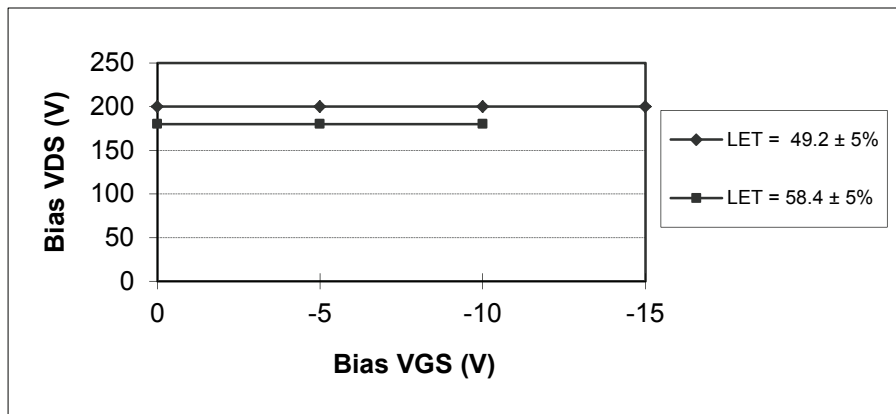


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the page 2.

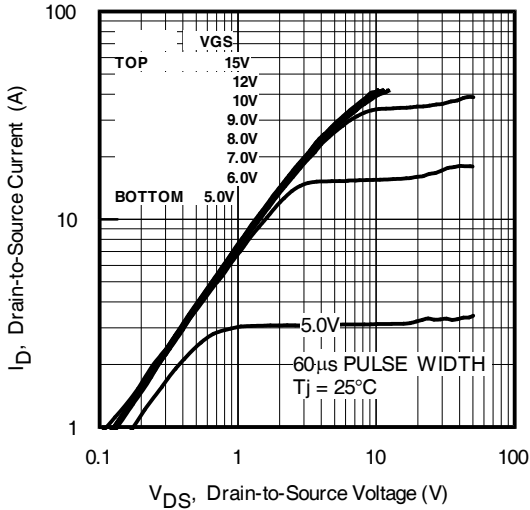


Fig 1. Typical Output Characteristics

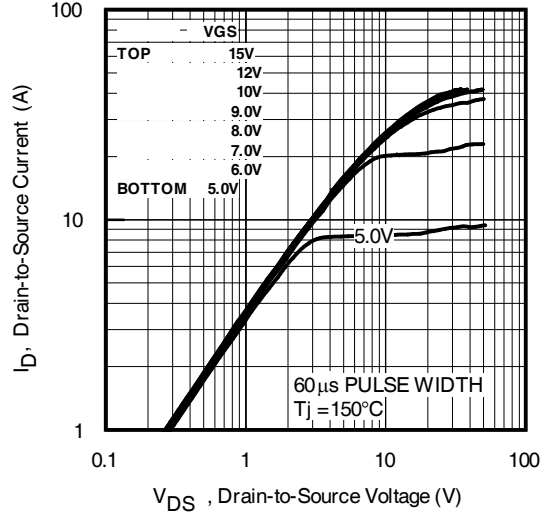


Fig 2. Typical Output Characteristics

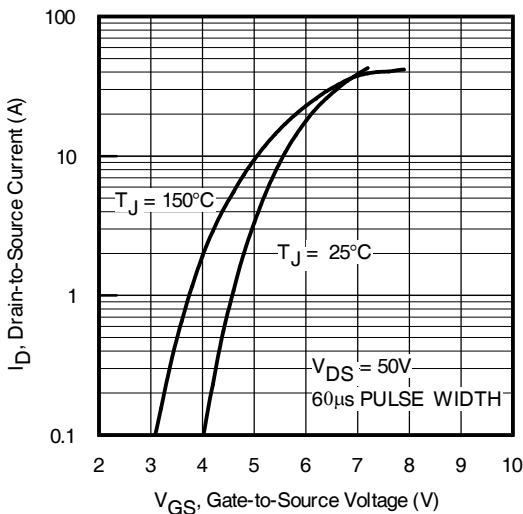


Fig 3. Typical Transfer Characteristics

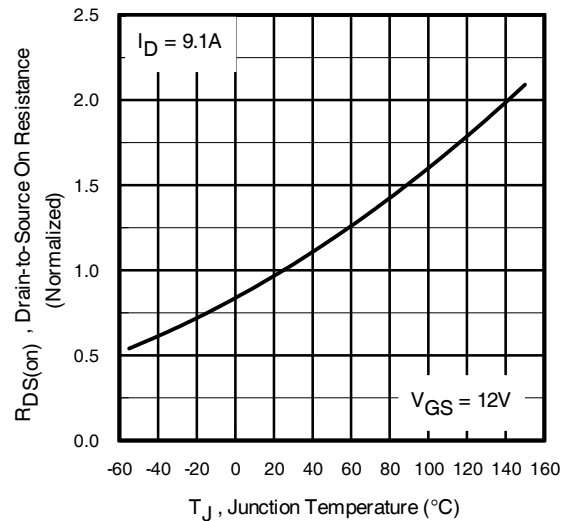


Fig 4. Normalized On-Resistance Vs. Temperature

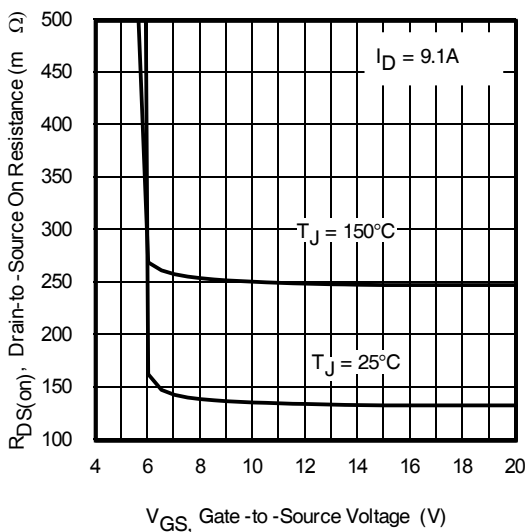


Fig 5. Typical On-Resistance Vs Gate Voltage

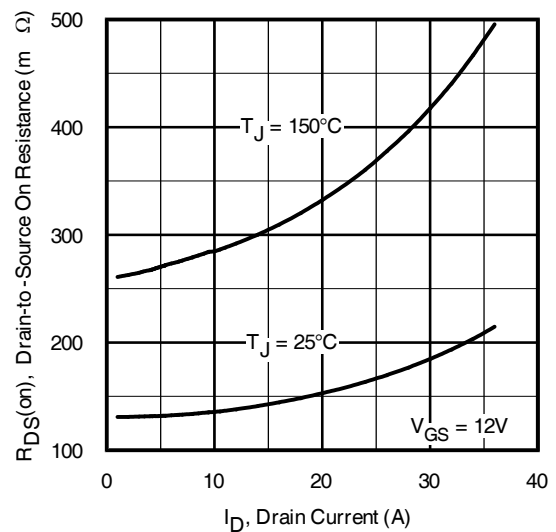


Fig 6. Typical On-Resistance Vs Drain Current

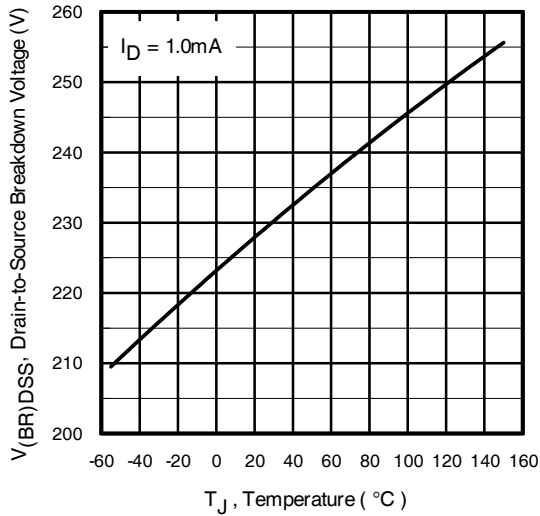


Fig 7. Typical Drain-to-Source Breakdown Voltage Vs Temperature

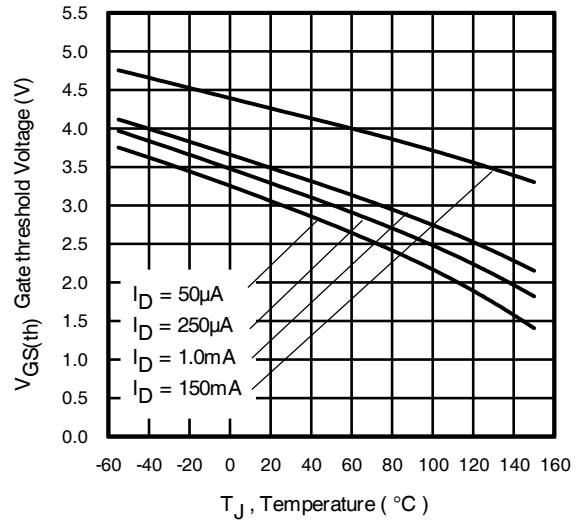


Fig 8. Typical Threshold Voltage Vs Temperature

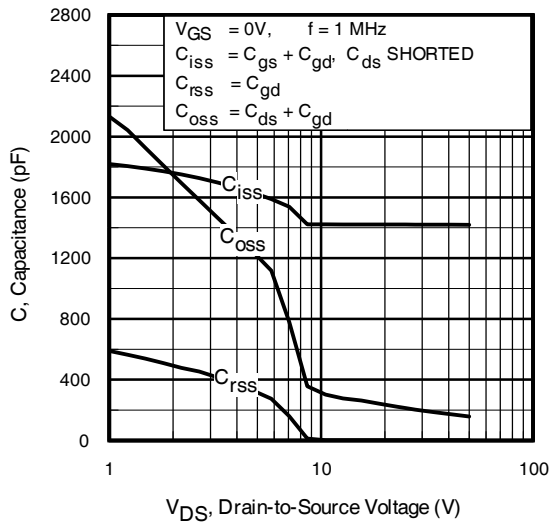


Fig 9. Typical Capacitance Vs. Drain-to-Source Voltage

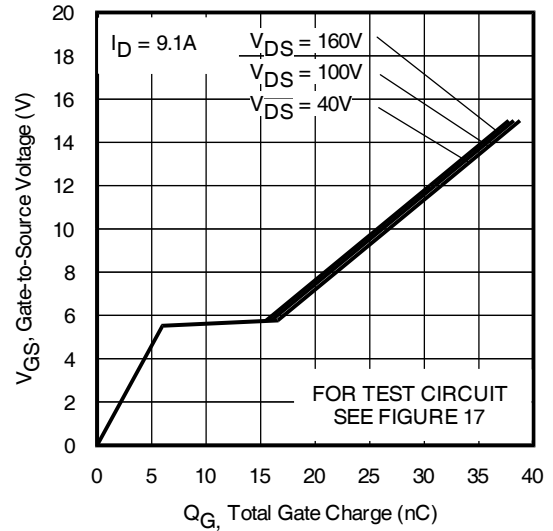


Fig 10. Typical Gate Charge Vs. Gate-to-Source Voltage

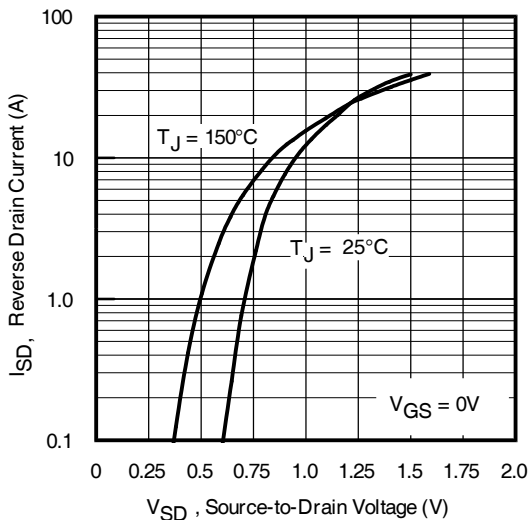


Fig 11. Typical Source-Drain Diode Forward Voltage

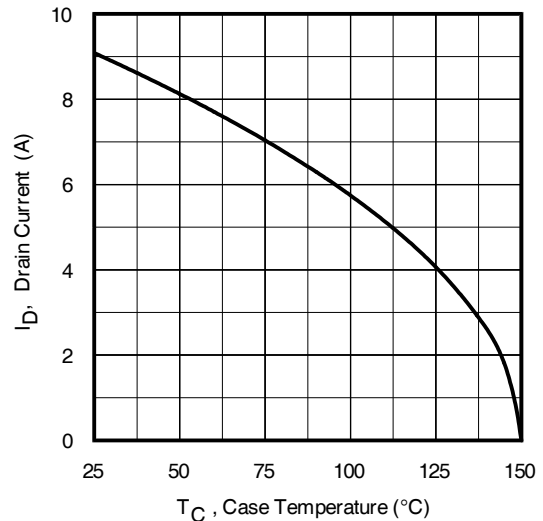


Fig 12. Maximum Drain Current Vs. Case Temperature

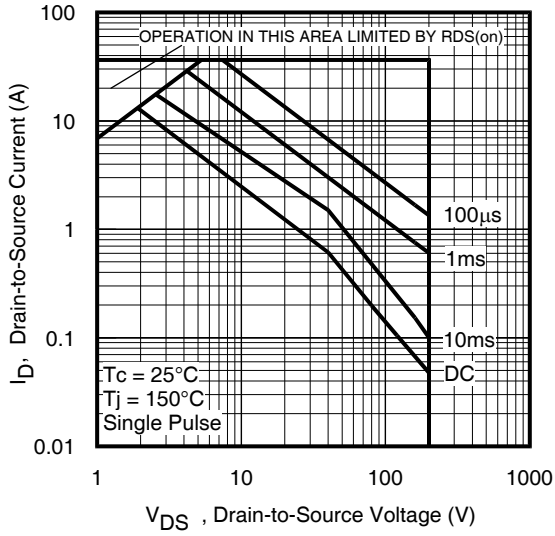


Fig 13. Maximum Safe Operating Area

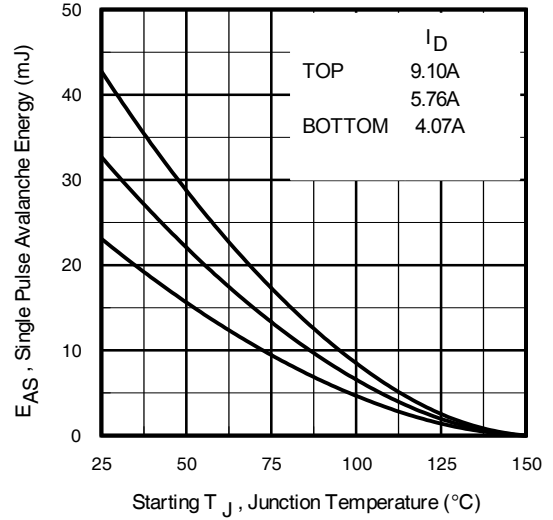


Fig 14. Maximum Avalanche Energy Vs. Drain Current

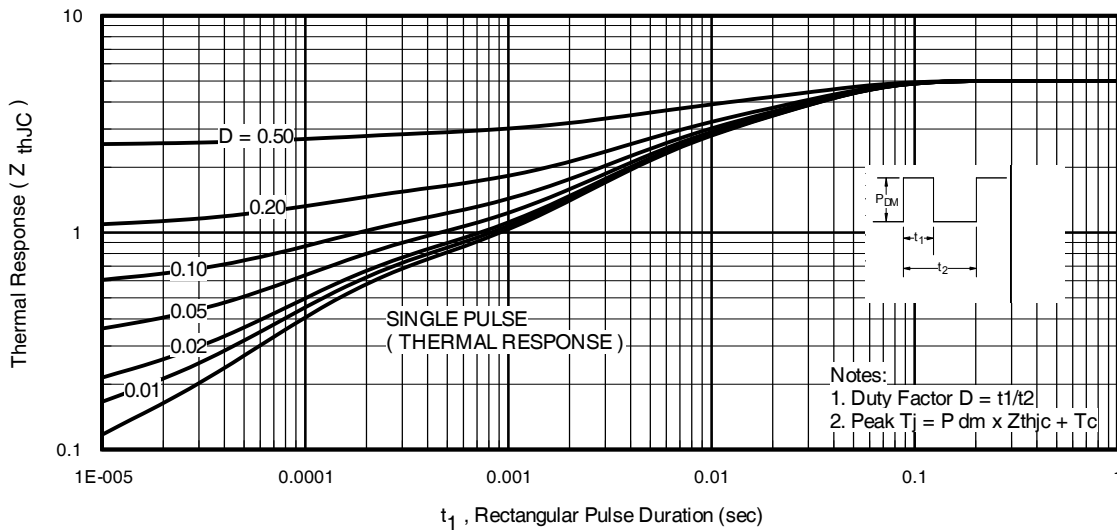


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

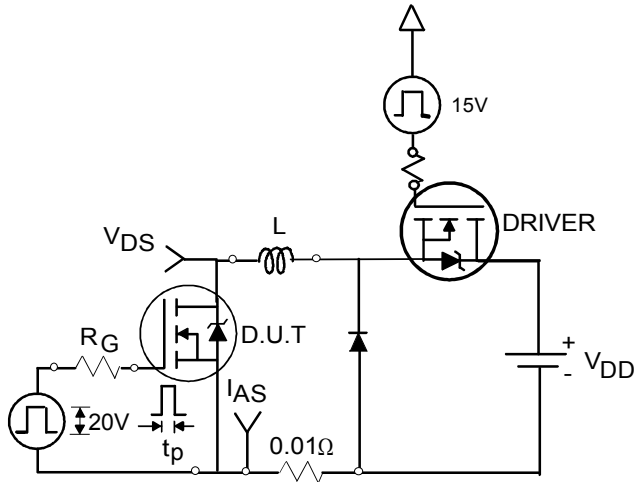


Fig 16a. Unclamped Inductive Test Circuit

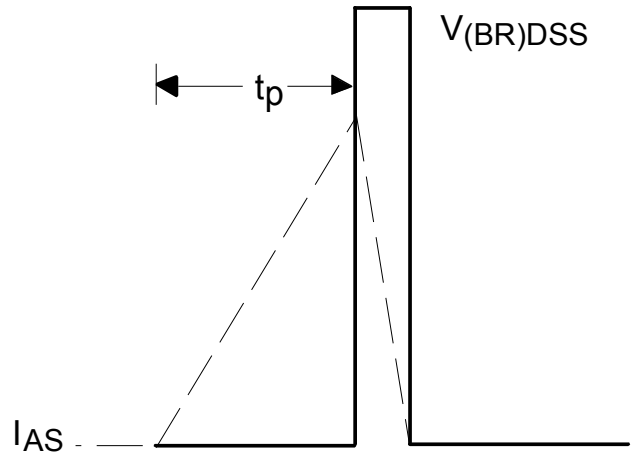


Fig 16b. Unclamped Inductive Waveforms

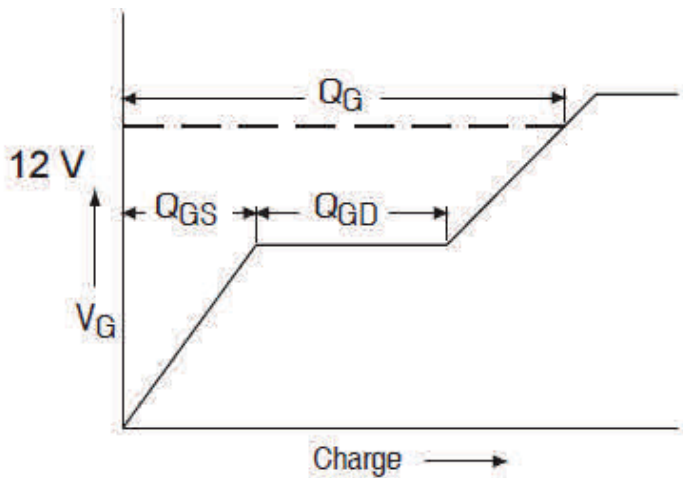


Fig 17a. Gate Charge Waveform

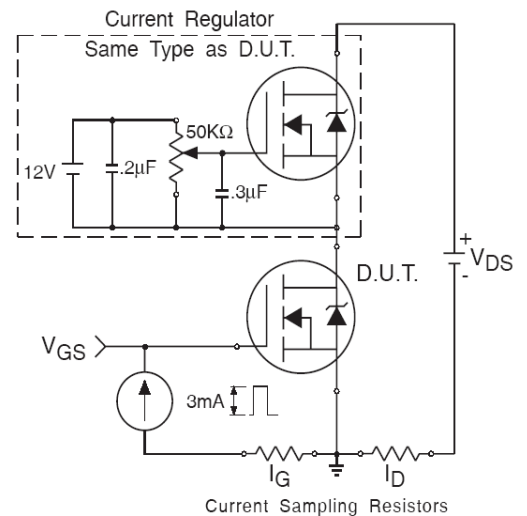


Fig 17b. Gate Charge Test Circuit

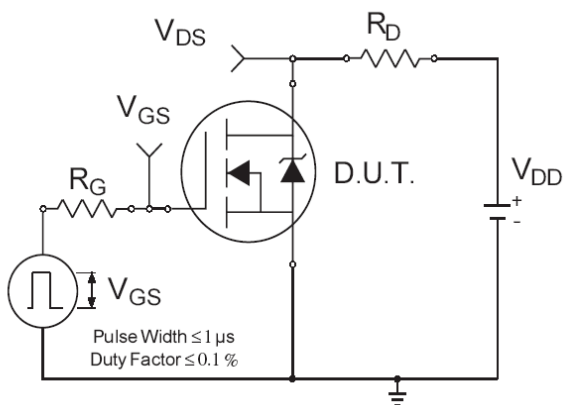


Fig 18a. Switching Time Test Circuit

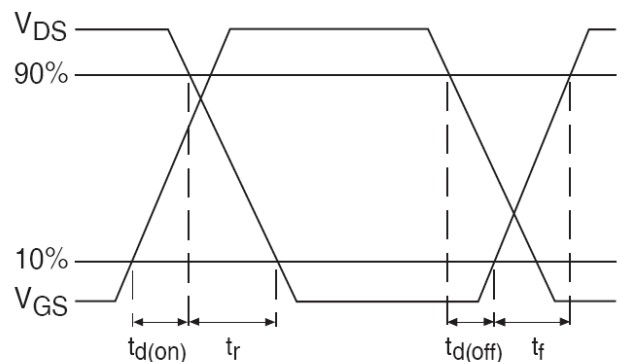
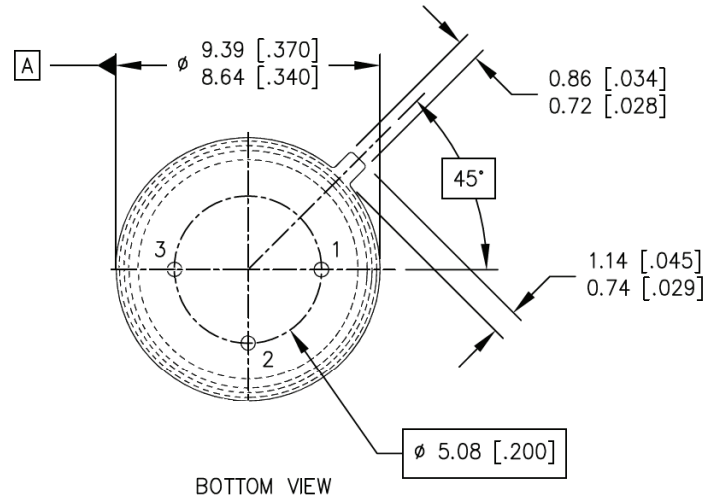
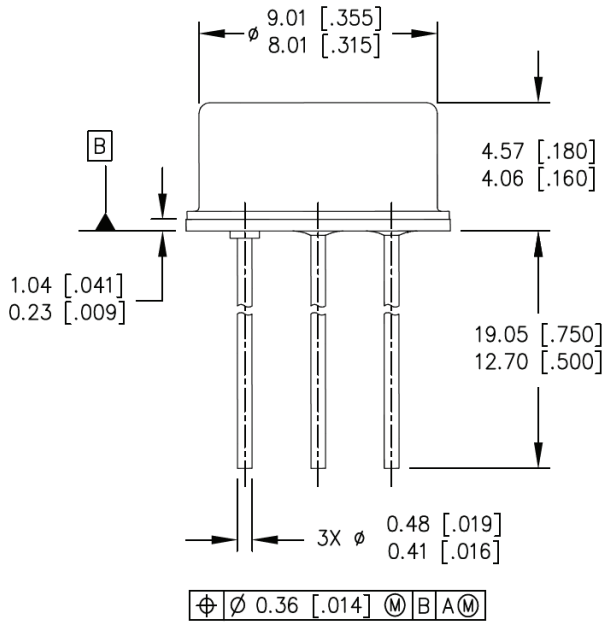


Fig 18b. Switching Time Waveforms

Case Outline and Dimensions - TO-205AF (TO-39)



$\text{⌀} \text{ } \text{⌀} 0.36 \text{ } [.014] \text{ } \text{Ⓜ} \text{ } \text{B} \text{ } \text{A} \text{ } \text{Ⓜ}$

SIDE VIEW

BOTTOM VIEW

LEGEND
1- SOURCE
2- GATE
3- DRAIN (CONNECTED TO THE CASE)

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME 14.5M-1994.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. CONTROLLING DIMENSION: INCH.
4. CONFORMS TO JEDEC OUTLINE TO-205AF (TO-39).

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