IR HiRel
An Infineon Technologies Company

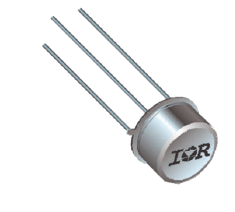
IRHF7230
JANSR2N7262

RADIATION HARDENED POWER MOSFET THRU-HOLE TO-205AF (TO-39)

200V, N-CHANNEL
REF: MIL-PRF-19500/601
RAD Hard™ HEXFET® TECHNOLOGY

Product Summary

Part Number	Radiation Level	RDS(on)	I_D	QPL Part Number
IRHF7230	100 kRads(Si)	0.35Ω	5.5A	JANSR2N7262
IRHF3230	300 kRads(Si)	0.35Ω	5.5A	JANSF2N7262
IRHF5230	500 kRads(Si)	0.35Ω	5.5A	JANSG2N7262
IRHF8230	1000 kRads(Si)	0.35Ω	5.5A	JANSH2N7262



TO-39

Description

IR HiRel RADHard™ HEXFET® MOSFET technology provides high performance power MOSFETs for space applications. This technology has long history 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 and temperature stability of electrical

Features

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Simple Drive Requirements
- Hermetically Sealed
- Light Weight
- ESD Rating: Class 1C per MIL-STD-750, Method 1020

Absolute Maximum Ratings

Pre-Irradiation

Symbol	Parameter	Value	Units
I_{D1} @ V_{GS} = 12V, T_C = 25°C	Continuous Drain Current	5.5	A
I_{D2} @ V_{GS} = 12V, T_C = 100°C	Continuous Drain Current	3.5	
I_{DM} @ T_C = 25°C	Pulsed Drain Current ①	22	
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	240	mJ
I_{AR}	Avalanche Current ①	5.5	A
E_{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	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)	g

For Footnotes, refer to the page 2.

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	—	—	V	V_{GS} = 0V, I_D = 1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.25	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	0.35	Ω	V_{GS} = 12V, I_{D2} = 3.5A ④
		—	—	0.364		V_{GS} = 12V, I_{D1} = 5.5A ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	V_{DS} = V_{GS}, I_D = 1.0mA
Gfs	Forward Transconductance	2.5	—	—	S	V_{DS} = 15V, I_{D2} = 3.5A ④
I_{DSS}	Zero Gate Voltage Drain Current	—	—	25	µA	V_{DS} = 160V, V_{GS} = 0V
		—	—	250		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	—	—	50	nC	I_{D1} = 5.5A
Q_{GS}	Gate-to-Source Charge	—	—	10		V_{DS} = 100V
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	25		V_{GS} = 12V
$t_{d(on)}$	Turn-On Delay Time	—	—	25	ns	V_{DD} = 100V
tr	Rise Time	—	—	40		I_{D1} = 5.5A
$t_{d(off)}$	Turn-Off Delay Time	—	—	60		R_G = 2.35Ω
t_f	Fall Time	—	—	45		V_{GS} = 12V
Ls +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 pin
C_{iss}	Input Capacitance	—	1100	—	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	—	250	—		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	—	55	—		f = 1.0MHz

Source-Drain Diode Ratings and Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	—	—	5.5	A	
I_{SM}	Pulsed Source Current (Body Diode) ①	—	—	22		
V_{SD}	Diode Forward Voltage	—	—	1.4	V	T_J = 25°C, I_S = 5.5A, V_{GS} = 0V④
t_{rr}	Reverse Recovery Time	—	—	400	ns	T_J = 25°C, I_F = 5.5A, V_{DD} ≤ 30V
Q_{rr}	Reverse Recovery Charge	—	—	3.0	µC	di/dt = 100A/µs ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S+L_D)				

Thermal Resistance

Symbol	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	—	5.0	°C/W
$R_{\theta JA}$	Junction-to-Ambient (Typical Socket Mount)	—	—	175	

Footnotes:

① Repetitive Rating; Pulse width limited by maximum junction temperature.

② V_{DD} = 50V, starting T_J = 25°C, L = 15.9mH, Peak I_L = 5.5A, V_{GS} = 10V

③ $I_{SD} \leq$ 5.5A, di/dt ≤ 120A/µs, $V_{DD} \leq$ 200V, $T_J \leq$ 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. 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 IR HiRel 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

Symbol	Parameter	100 kRads (Si)[1]		Up to 300k - 1000 kRads (Si)[2]		Units	Test Conditions
		Min.	Max.	Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	——	200	——	V	V_{GS} = 0V, I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	1.25	4.5	V	V_{DS} = V_{GS}, 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	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	——	25	——	25	µA	V_{DS} = 160V, V_{GS} = 0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	——	0.35	——	0.48	Ω	V_{GS} = 12V, I_{D2} = 3.5A
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-39)	——	0.35	——	0.48	Ω	V_{GS} = 12V, I_{D2} = 3.5A
V_{SD}	Diode Forward Voltage ④	——	1.4	——	1.4	V	V_{GS} = 0V, I_S = 5.5A

1. Part numbers IRHF7230 (JANSR2N7262)
2. Part numbers IRHF3230 (JANSF2N7262) and IRHF4230(JANSG2N7262), IRHF8230 (JANSH2N7262)

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

Ion	LET (MeV/(mg/cm²))	Energy (MeV)	Range (µm)	VDS (V)				
				@ VGS = 0V	@ VGS = -5V	@ VGS = -10V	@ VGS = -15V	@ VGS = -20V
Cu	28	285	43	190	180	170	125	——
Br	36.8	305	39	100	100	100	50	——

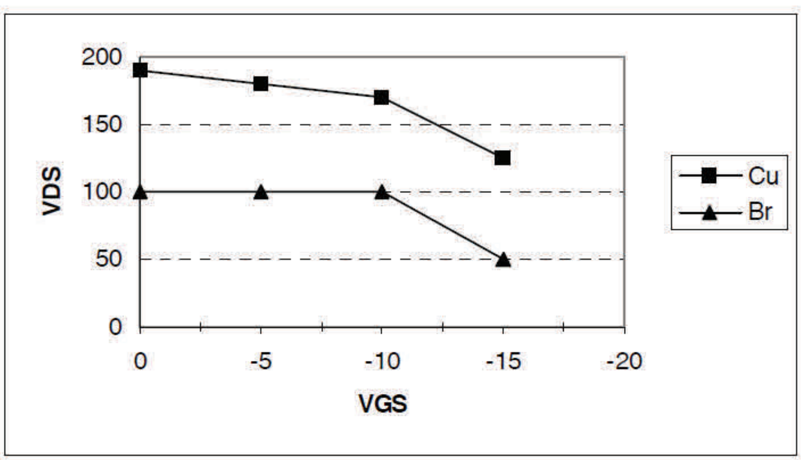


Fig a. Typical Single Event Effect, Safe Operating Area

For Footnotes, refer to the page 2.

Pre-Irradiation

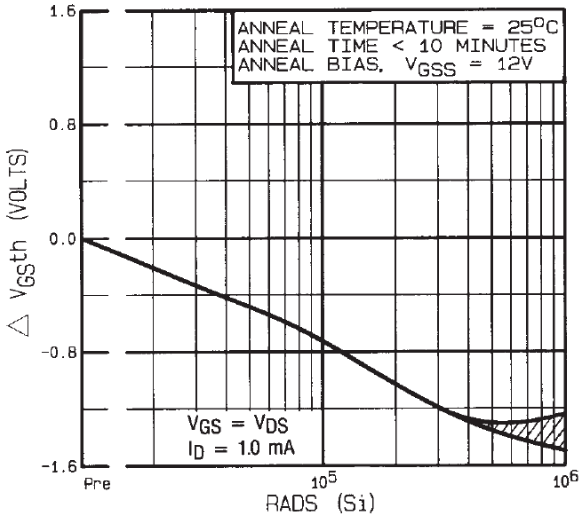


Fig 1. Typical Response of Gate Threshhold

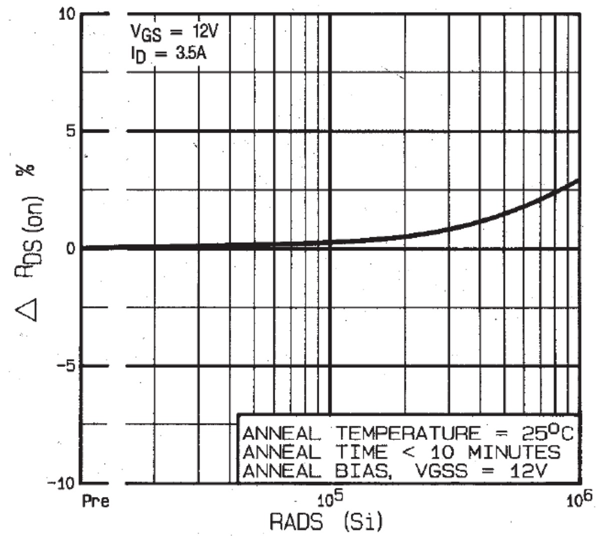


Fig 2. Typical Response of On-State Resistance Vs. Total Dose Exposure

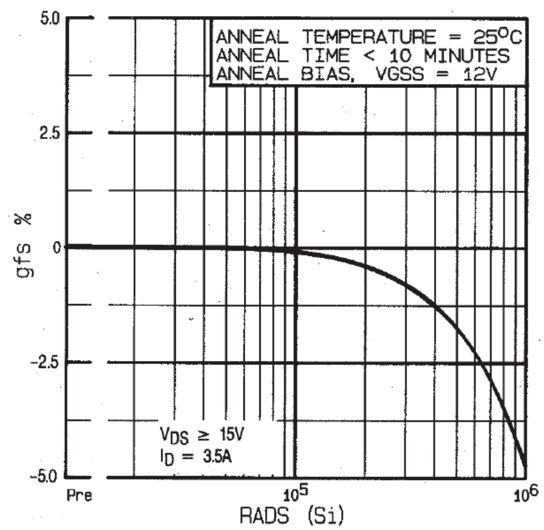


Fig 3. Typical Response of Transconductance Vs. Total Dose Exposure

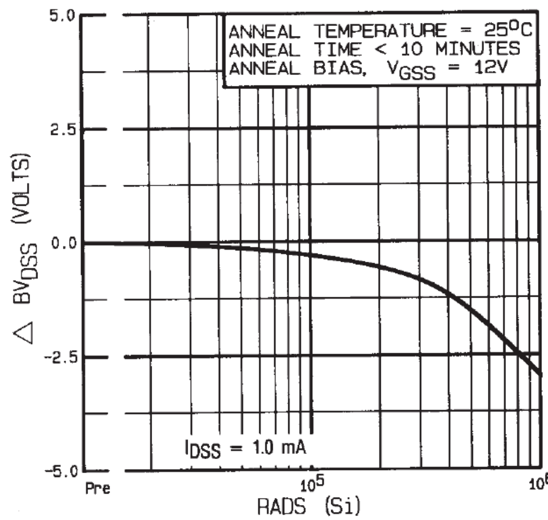


Fig 4. Typical Response of Drain to Source Breakdown Vs. Total Dose Exposure

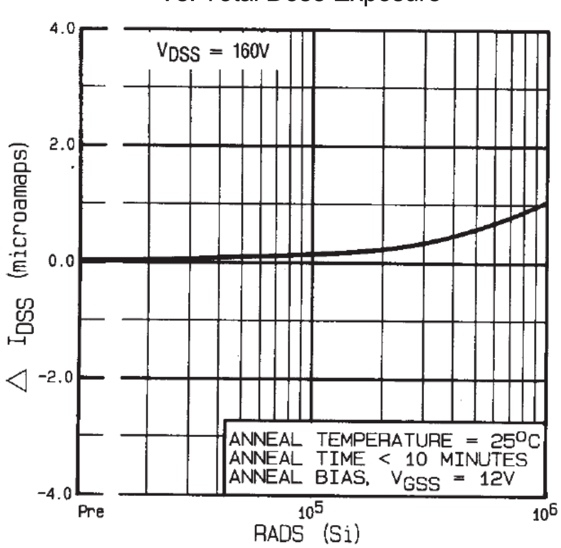


Fig 5. Typical Zero Gate Voltage Drain Current Vs. Total Dose Exposure

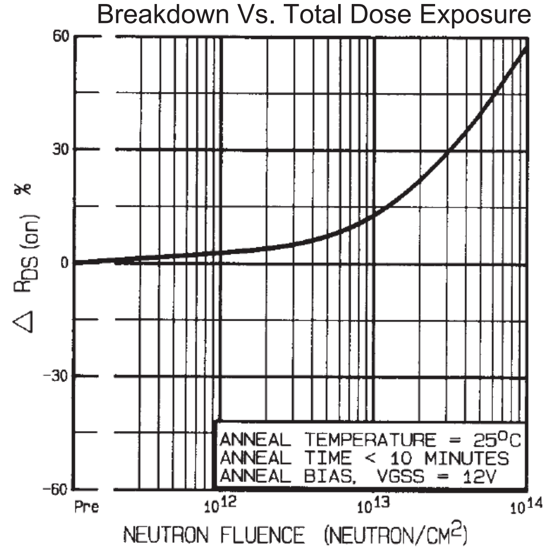


Fig 6. Typical On-State Resistance Vs. Neutron Fluence Level

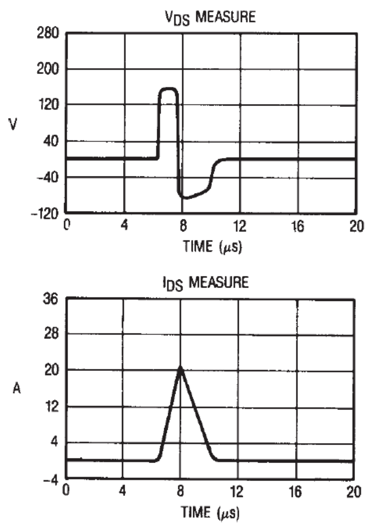


Fig 7. Typical Transient Response of Rad Hard HEXFET During $1x10^{12}$ Rad (Si)/Sec Exposure

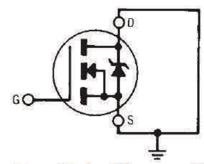


Fig 8a. Gate Stress of V_{GSS} Equals 12 Volts During Radiation

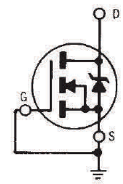


Fig 8b. V_{DSS} Stress Equals 80% of B_{VDSS} During Radiation

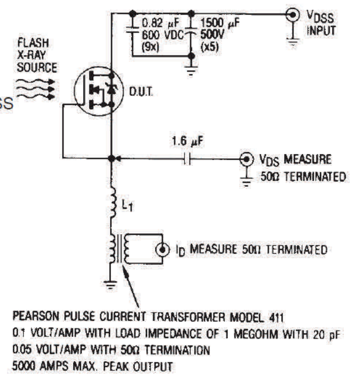


Fig 9. High Dose Rate (Gamma Dot) Test Circuit

Note: Bias Conditions during radiation: V_{GS} = 12 Vdc, V_{DS} = 0 Vdc, Fig-10,11,12,13

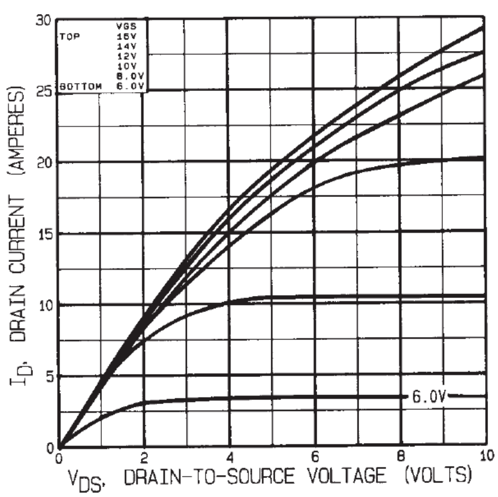


Fig 10. Typical Output Characteristics Pre-Irradiation

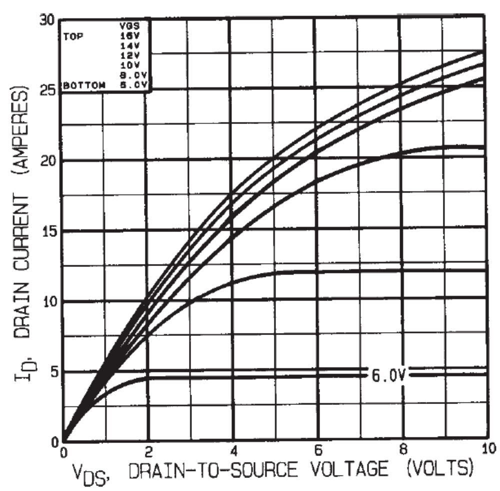


Fig 11. Typical Output Characteristics Post-Irradiation 100K Rads (Si)

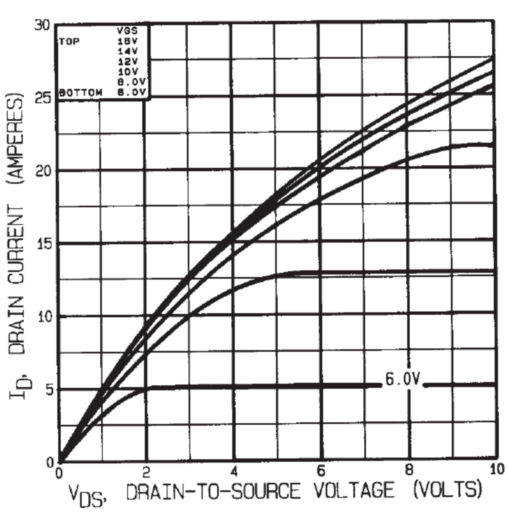


Fig 12. Typical Output Characteristics Post-Irradiation 300K Rads (Si)

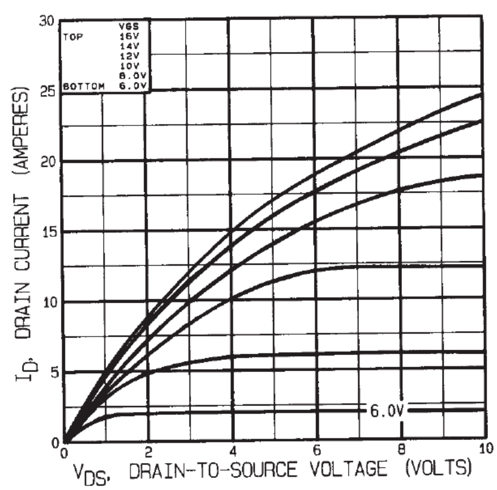


Fig 13. Typical Output Characteristics Post-Irradiation 1 Mega Rads (Si)

Note: Bias Conditions during radiation: V_{GS} = 0 Vdc, V_{DS} = 160 Vdc Fig 14,15, 16,17

Pre-Irradiation

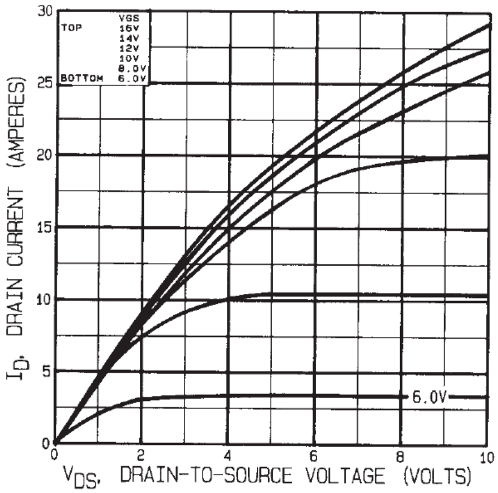


Fig 14. Typical Output Characteristics Pre-Irradiation

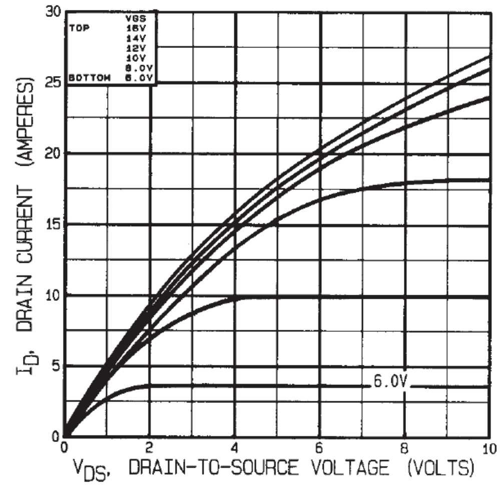


Fig 15. Typical Output Characteristics Post-Irradiation 100K Rads (Si)

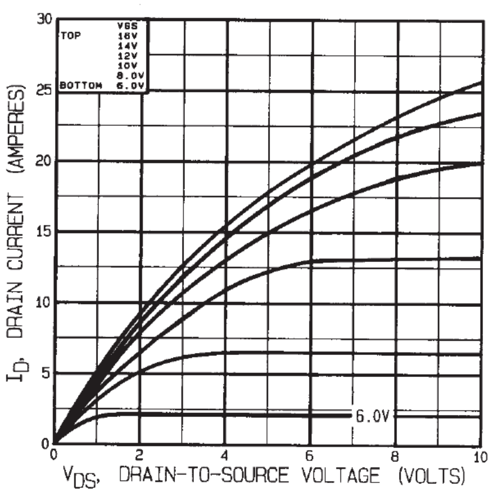


Fig 16. Typical Output Characteristics

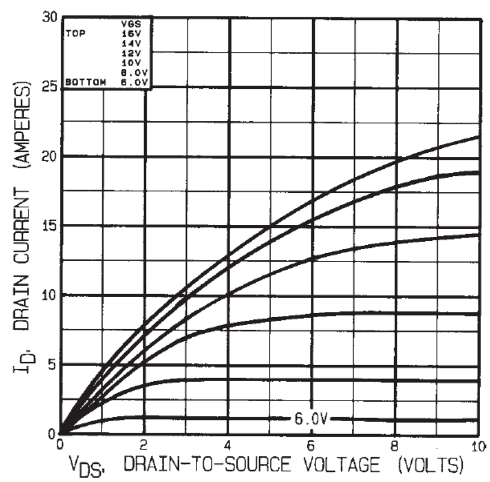


Fig 17. Typical Output Characteristics Post-Irradiation 1 Mega Rads (Si)

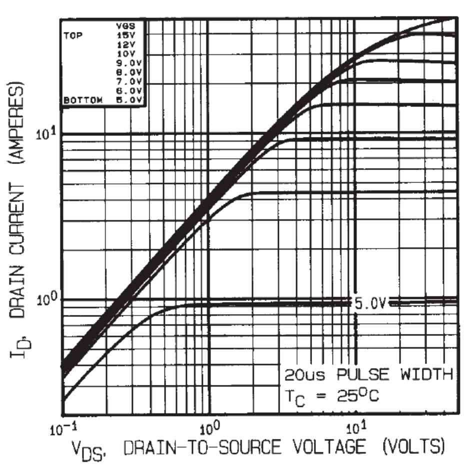


Fig 18. Typical Output Characteristics

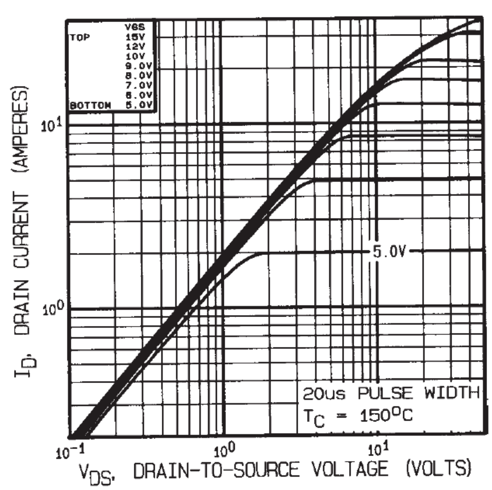


Fig 19. Typical Output Characteristics

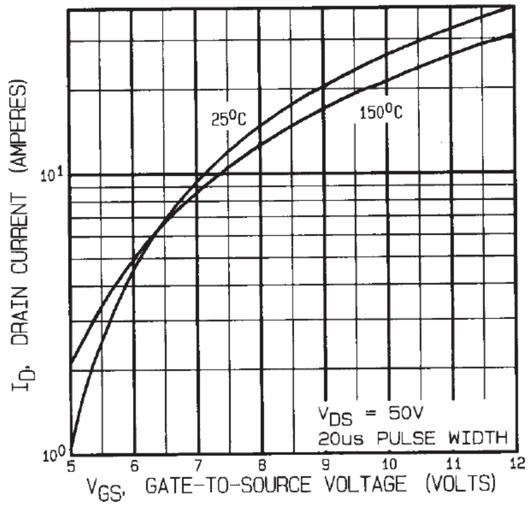


Fig 20. Typical Transfer Characteristics

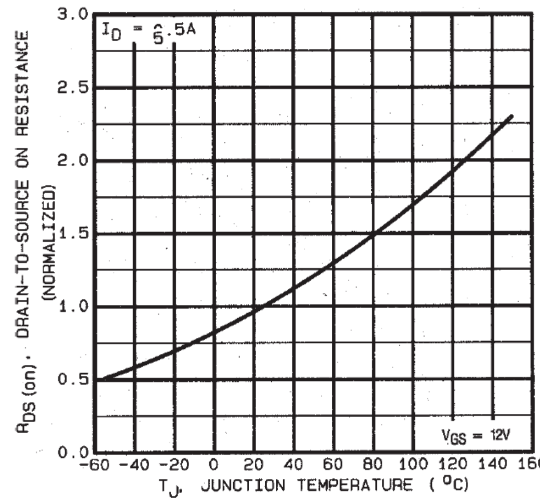


Fig 21. Normalized On-Resistance Vs. Temperature

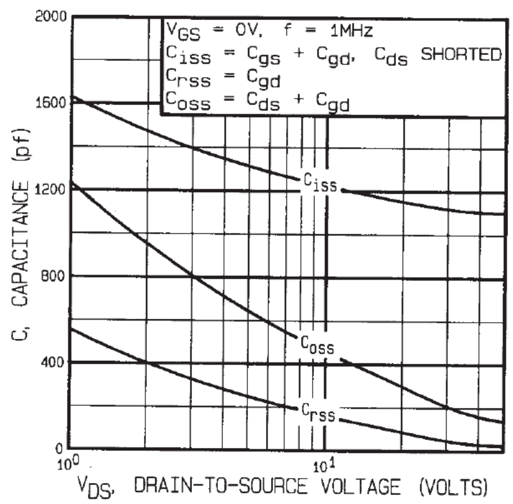


Fig 22. Typical Capacitance Vs. Drain-to-Source Voltage

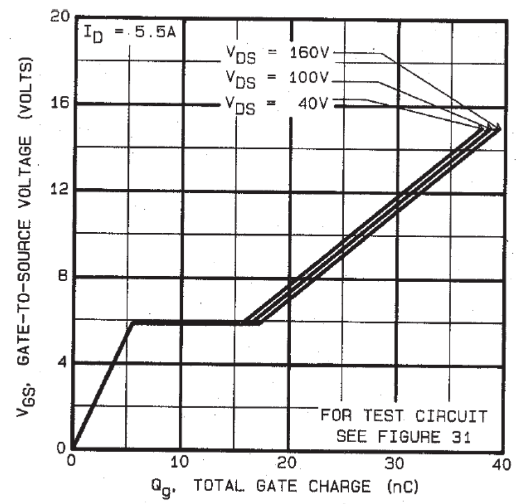


Fig 23. Typical Gate Charge Vs. Gate-to-Source Voltage

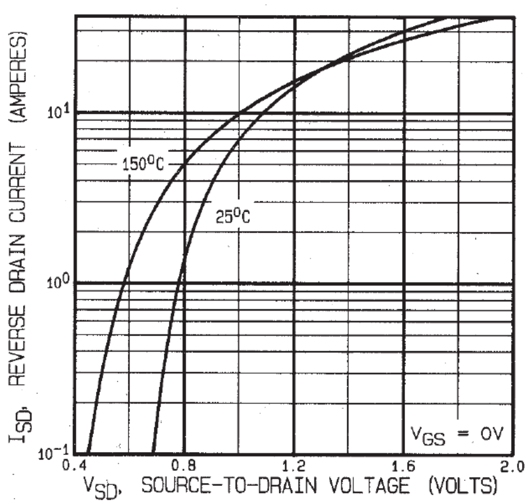


Fig 24. Typical Source-Drain Diode Forward Voltage

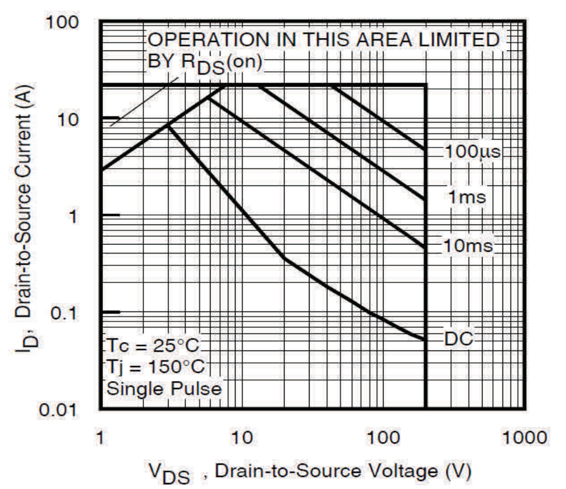


Fig 25. Maximum Safe Operating Area

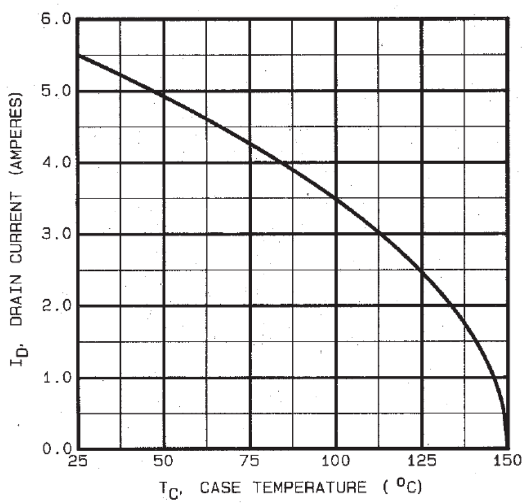


Fig 26. Maximum Drain Current Vs. Case Temperature

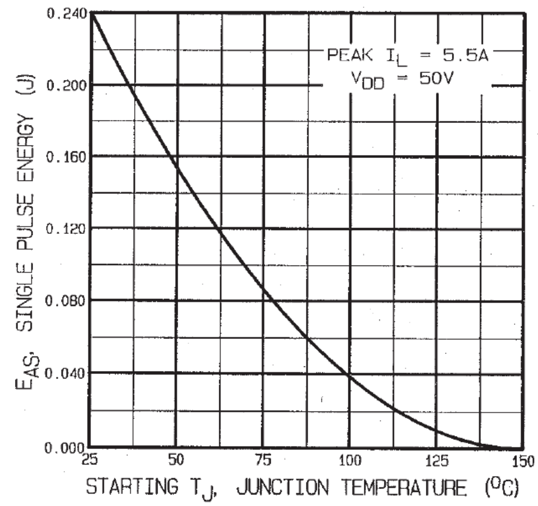


Fig 27. Maximum Avalanche Energy Vs. Drain Current

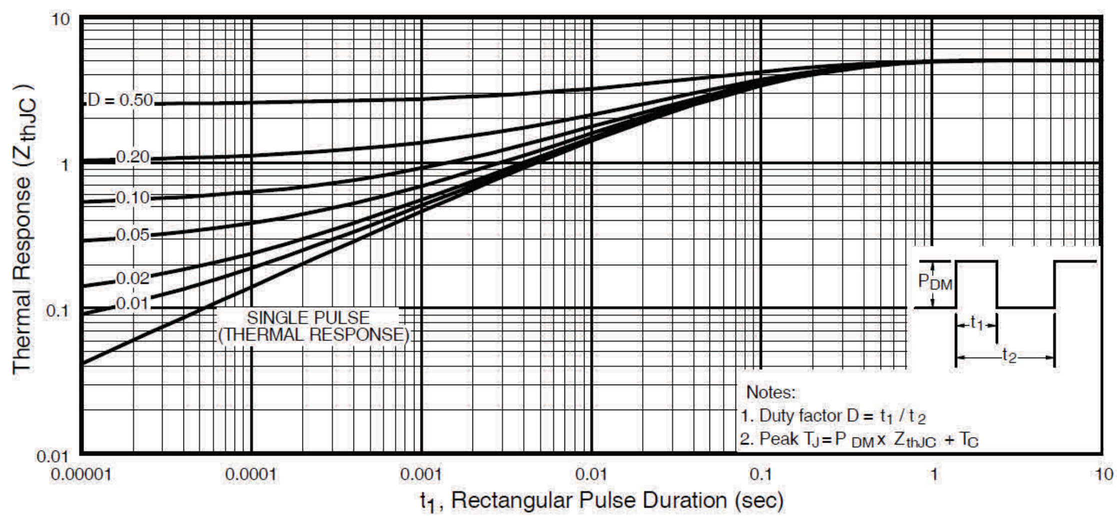


Fig 28. Maximum Effective Transient Thermal Impedance, Junction-to-Case

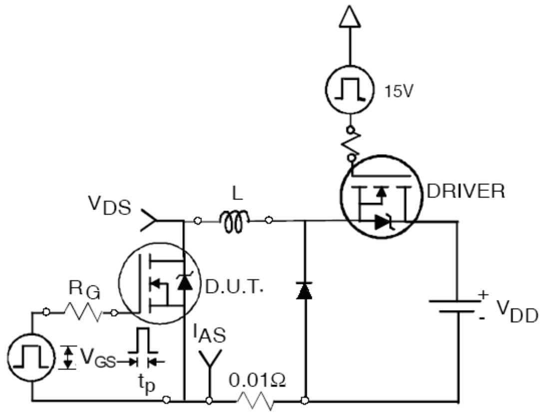


Fig 29a. Unclamped Inductive Test Circuit

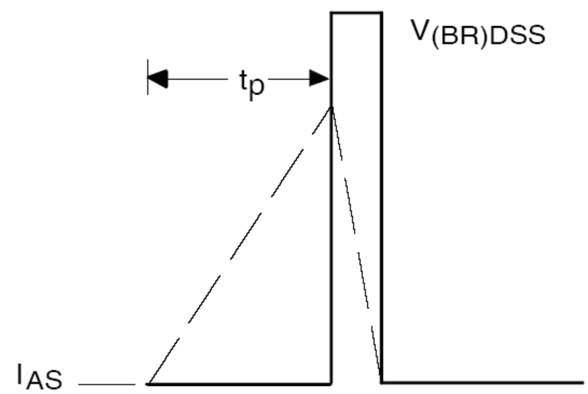


Fig 29b. Unclamped Inductive Waveforms

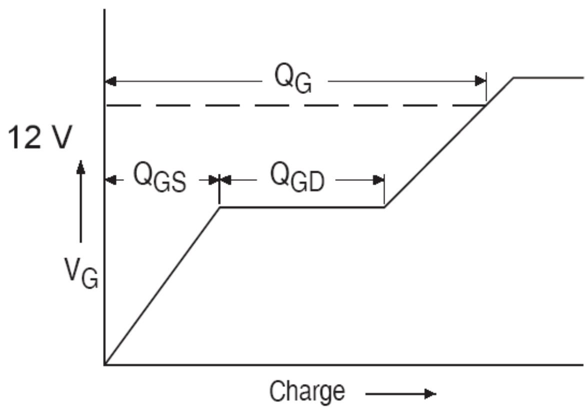


Fig 30a. Gate Charge Waveform

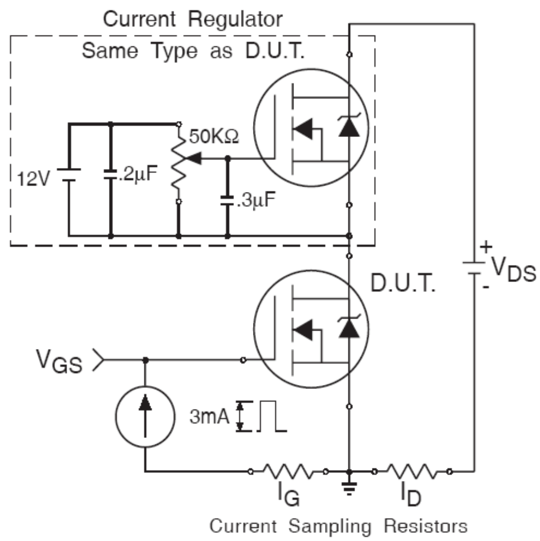


Fig 30b. Gate Charge Test Circuit

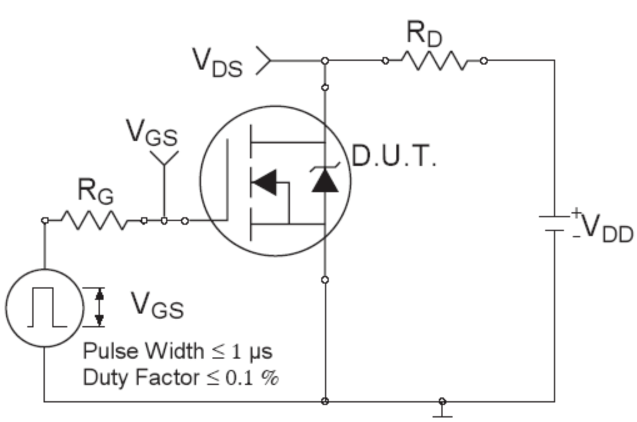


Fig 31a. Switching Time Test Circuit

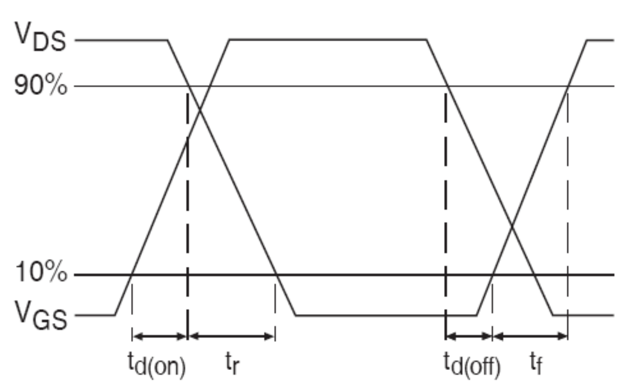
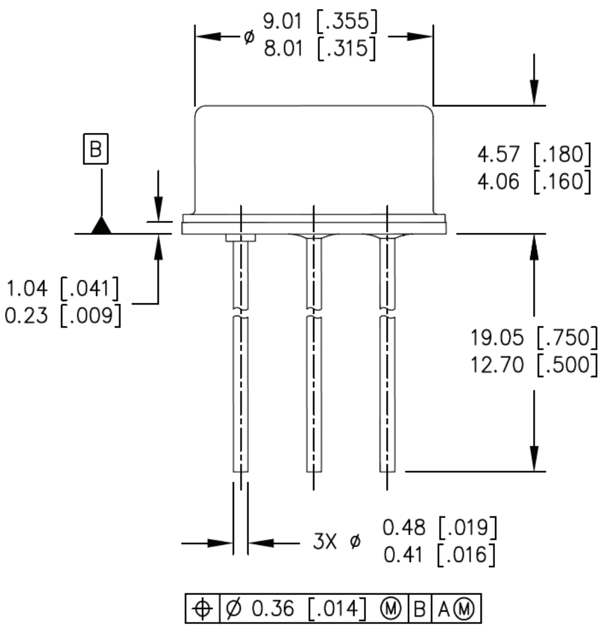
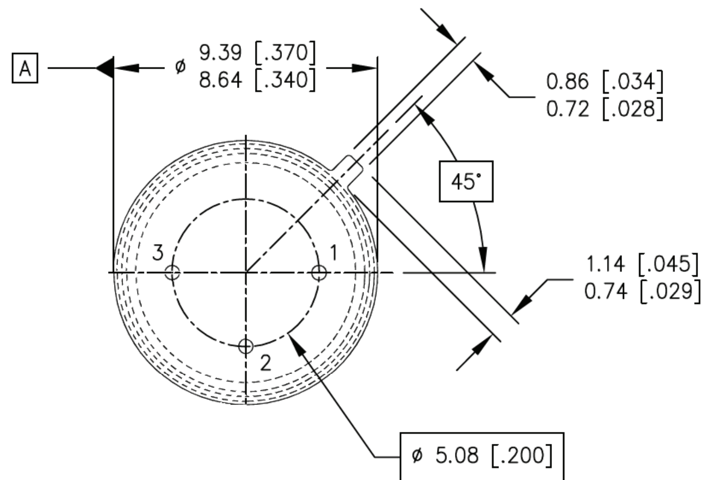


Fig 31b. Switching Time Waveforms

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



SIDE VIEW



BOTTOM VIEW

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).

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

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www.infineon.com/irhirel
Infineon Technologies Service Center: USA Tel: +1 (866) 951-9519 and International Tel: +49 89 234 65555
Leominster, Massachusetts 01453, USA Tel: +1 (978) 534-5776
San Jose, California 95134, USA Tel: +1 (408) 434-5000

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