An Infineon Technologies Company

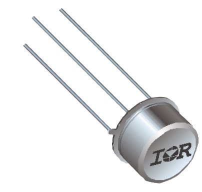
IRHF9130
JANSR2N7389

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

100V, P-CHANNEL
REF: MIL-PRF-19500/630
RAD Hard™HEXFET ® TECHNOLOGY

Product Summary

Part Number	Radiation Level	RDS(on)	I_D	QPL Part Number
IRHF9130	100 kRads(Si)	0.30Ω	-6.5A	JANSR2N7389
IRHF93130	300 kRads(Si)	0.30Ω	-6.5A	JANSF2N7389



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 parameters.

Features

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Proton Tolerant
- Simple Drive Requirements
- Hermetically Sealed
- Ceramic Package
- Light Weight
- ESD Rating: Class 1B 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	-6.5	
I_{D2} @ V_{GS} = -12V, T_C = 100°C	Continuous Drain Current	-4.1	A
I_{DM} @ T_C = 25°C	Pulsed Drain Current ①	-26	
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	165	mJ
I_{AR}	Avalanche Current ①	-6.5	A
E_{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-22	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	-100	——	——	V	V_{GS} = 0V, I_D = -1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	-0.112	——	V/°C	Reference to 25°C, I_D = -1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	——	0.30	Ω	V_{GS} = -12V, I_{D2} = -4.1A ④
		——	——	0.35		V_{GS} = -12V, I_{D1} = -6.5A 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} = -4.1A ④
I_{DSS}	Zero Gate Voltage Drain Current	——	——	-25	µA	V_{DS} = -80V, V_{GS} = 0V
		——	——	-250		V_{DS} = -80V, 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} = -6.5A
Q_{GS}	Gate-to-Source Charge	——	——	10		V_{DS} = -50V
Q_{GD}	Gate-to-Drain ('Miller') Charge	——	——	25		V_{GS} = -12V
$t_{d(on)}$	Turn-On Delay Time	——	——	30	ns	V_{DD} = -50V
tr	Rise Time	——	——	50		I_{D1} = -6.5A
$t_{d(off)}$	Turn-Off Delay Time	——	——	70		R_G = 7.5Ω
t_f	Fall Time	——	——	70		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	——	1200	——	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	——	290	——		V_{DS} = -25V
C_{rss}	Reverse Transfer Capacitance	——	76	——		f = 1.0MHz

Source-Drain Diode Ratings and Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	——	——	-6.5	A	
I_{SM}	Pulsed Source Current (Body Diode) ①	——	——	-26		
V_{SD}	Diode Forward Voltage	——	——	-3.0	V	T_J = 25°C, I_S = -6.5A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	——	——	250	ns	T_J = 25°C, I_F = -6.5A, V_{DD} ≤ -50V
Q_{rr}	Reverse Recovery Charge	——	——	0.74	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} = -25V, starting T_J = 25°C, L = 7.8mH, Peak I_L = -6.5A, V_{GS} = -12V

③ I_{SD} ≤ -6.5A, di/dt ≤ -430A/µs, V_{DD} ≤ -100V, 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. -80 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]		300 kRads (Si)[2]		Units	Test Conditions
		Min.	Max.	Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	——	-100	——	V	V_{GS} = 0V, I_D = -1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	-4.0	-2.0	-5.0	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} = -80V, V_{GS} = 0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	——	0.30	——	0.30	Ω	V_{GS} = -12V, I_{D2} = -4.1A
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-39)	——	0.30	——	0.30	Ω	V_{GS} = -12V, I_{D2} = -4.1A
V_{SD}	Diode Forward Voltage ④	——	-3.0	——	-3.0	V	V_{GS} = 0V, I_S = -6.5A

1. Part numbers IRHF9130 (JANSR2N7389)
2. Part numbers IRHF91230 (JANSF2N7389)

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	-100	-100	-100	-70	-50
Kr	38.8	320	39.6	-100	-100	-75	-50	——
Xe	63.4	348	32.5	-50	——	——	——	——

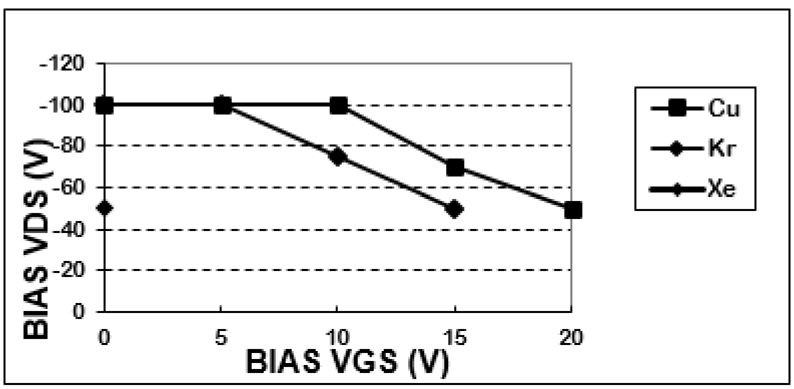


Fig a. Typical Single Event Effect, Safe Operating Area

For Footnotes, refer to the page 2.

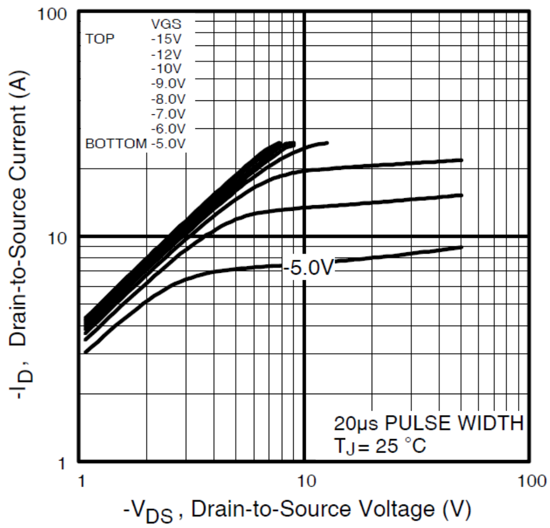


Fig 1. Typical Output Characteristics

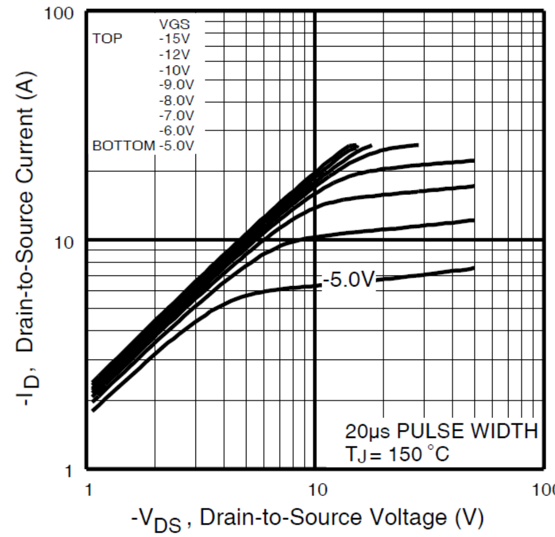


Fig 2. Typical Output Characteristics

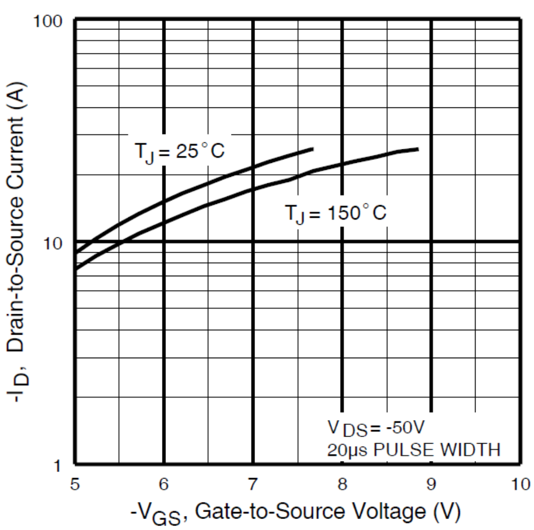


Fig 3. Typical Transfer Characteristics

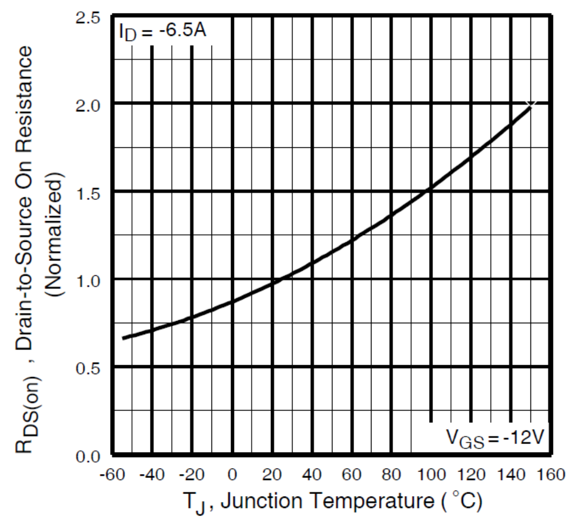


Fig 4. Normalized On-Resistance Vs. Temperature

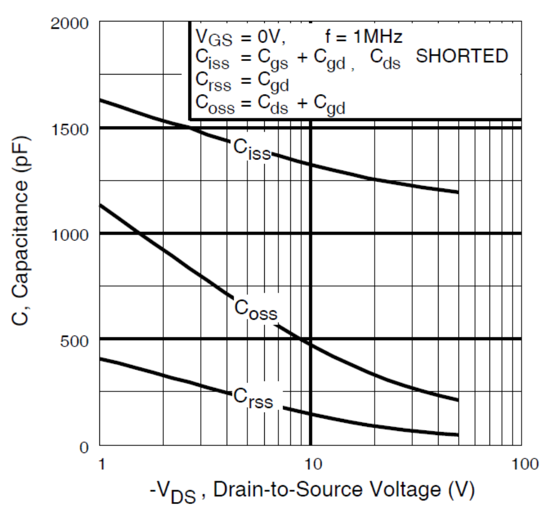


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

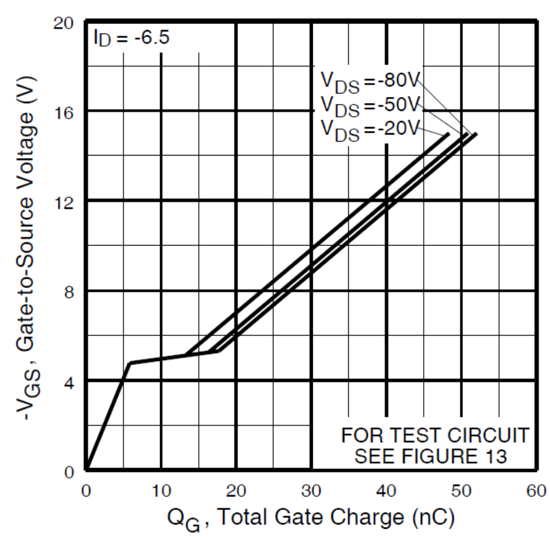


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

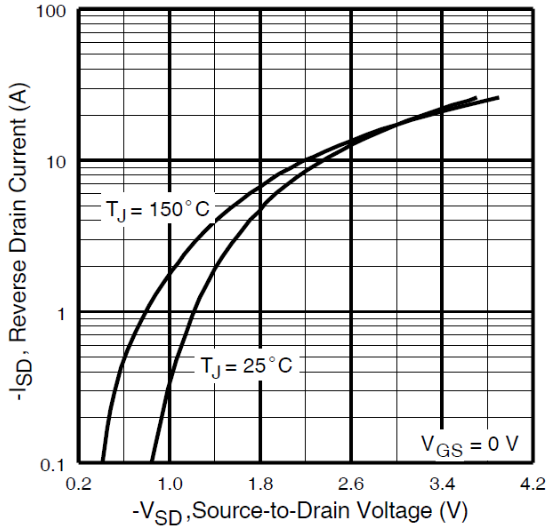


Fig 7. Typical Source-Drain Diode Forward Voltage

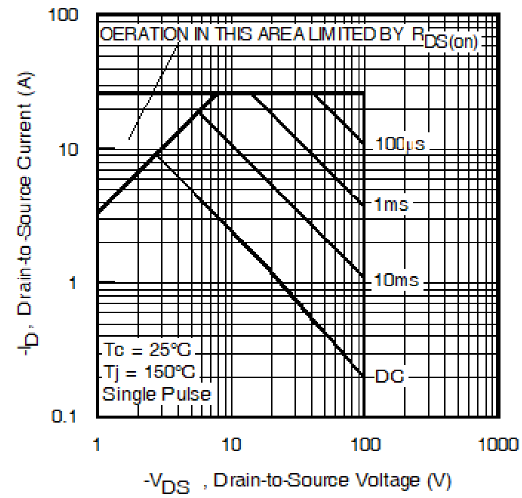


Fig 8. Maximum Safe Operating Area

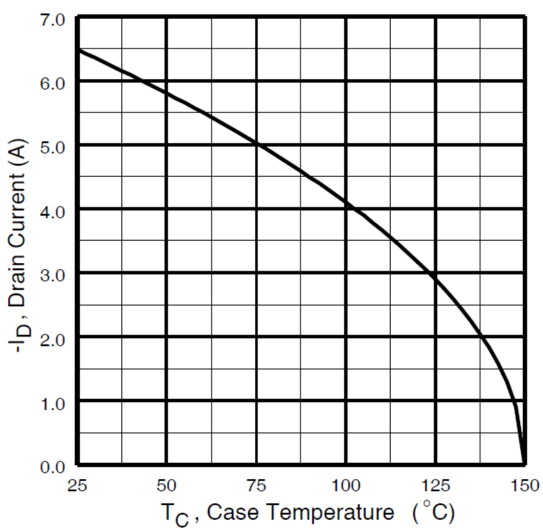


Fig 9. Maximum Drain Current Vs. Case Temperature

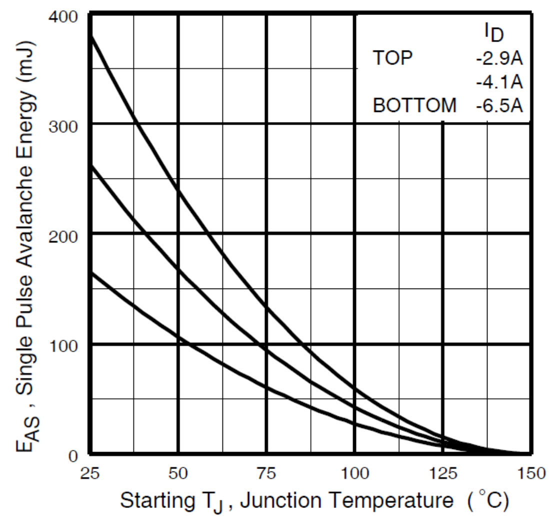


Fig 10. Maximum Avalanche Energy Vs. Drain Current

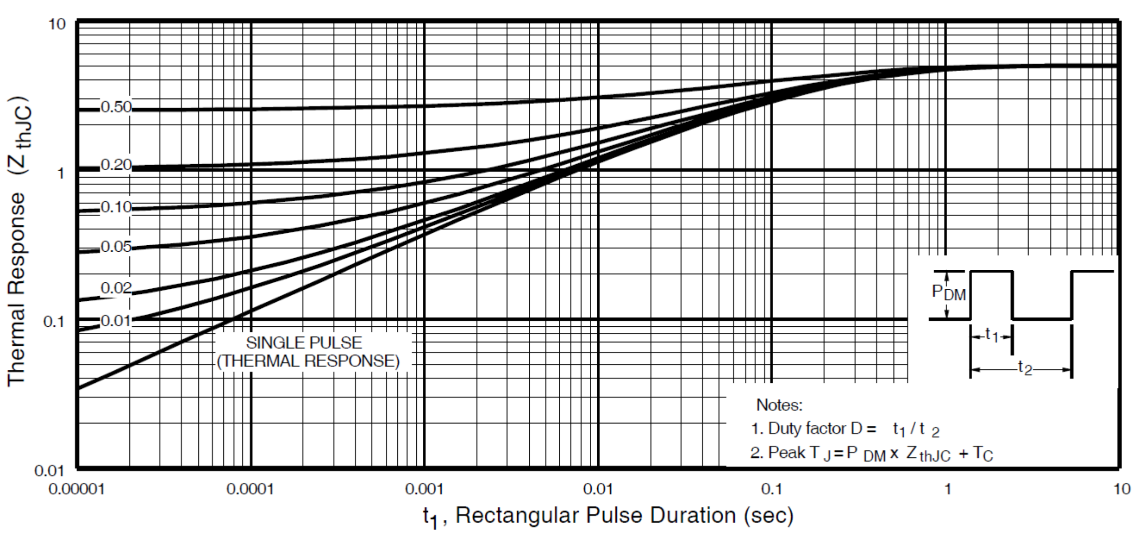


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

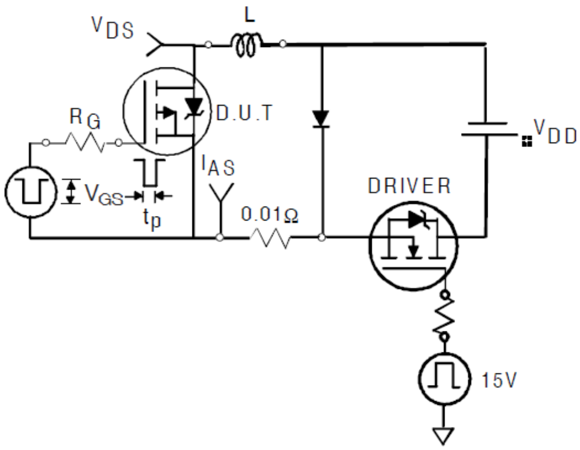


Fig 12a. Unclamped Inductive Test Circuit

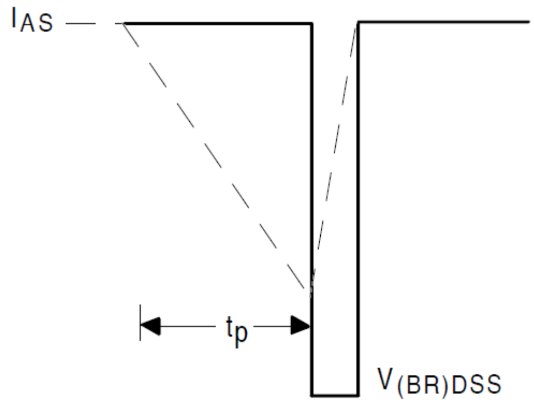


Fig 12b. Unclamped Inductive Wave-

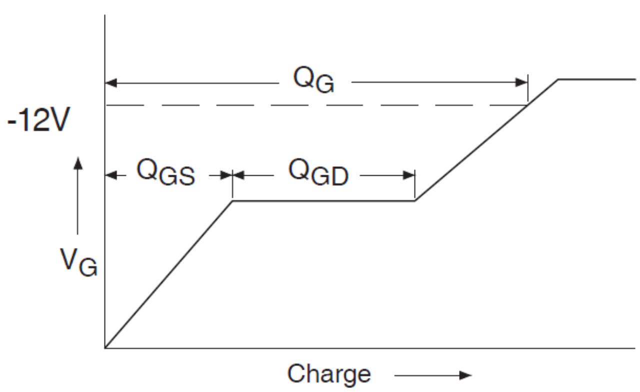


Fig 13a. Gate Charge Waveform

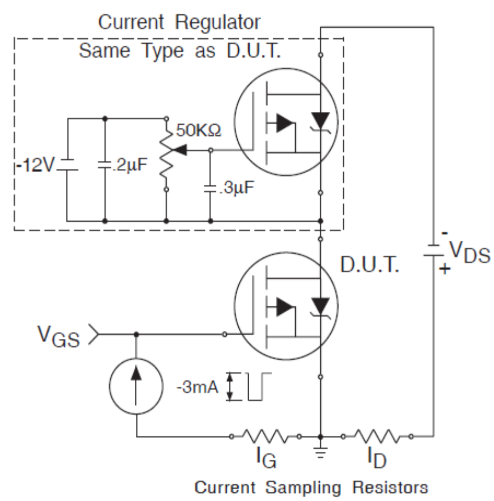


Fig 13b. Gate Charge Test Circuit

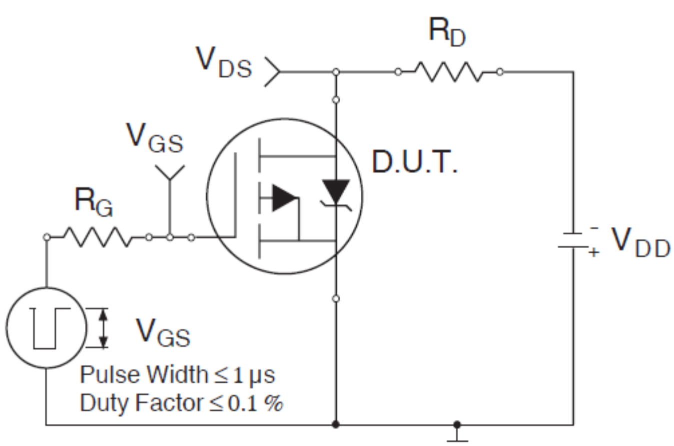


Fig 14a. Switching Time Test Circuit

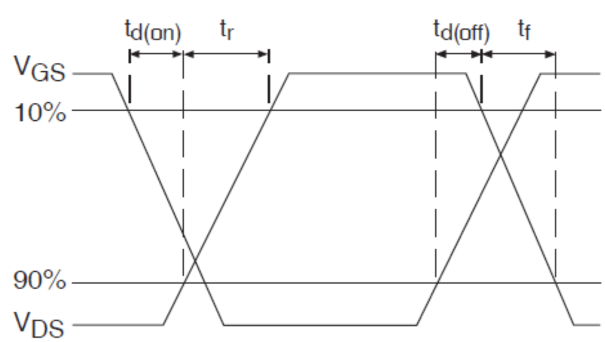
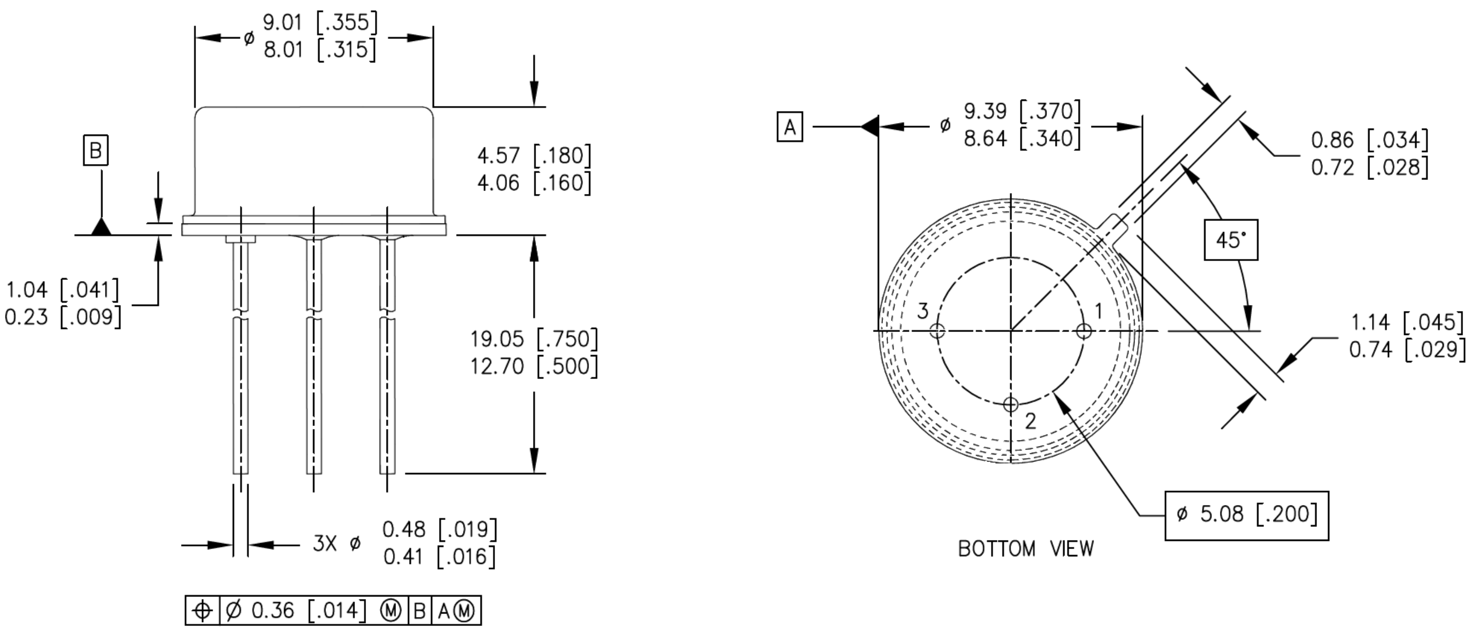


Fig 14b. Switching Time Waveforms

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



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).

An Infineon Technologies Company
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
Data and specifications subject to change without notice.

IMPORTANT NOTICE

The information given in this document shall be in no event regarded as guarantee of conditions or characteristic. The data contained herein is a characterization of the component based on internal standards and is intended to demonstrate and provide guidance for typical part performance. It will require further evaluation, qualification and analysis to determine suitability in the application environment to confirm compliance to your system requirements.

With respect to any example hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind including without limitation warranties on non- infringement of intellectual property rights and any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's product and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of any customer's technical departments to evaluate the suitability of the product for the intended applications and the completeness of the product information given in this document with respect to applications.

For further information on the product, technology, delivery terms and conditions and prices, please contact your local sales representative or go to (www.infineon.com/hirel).

WARNING

Due to technical requirements products may contain dangerous substances. For information on the types in question, please contact your nearest Infineon Technologies office.