International Rectifier
AN INFINEON TECHNOLOGIES COMPANY

PD-97833

2N7610T2

RADIATION HARDENED LOGIC LEVEL POWER MOSFET THRU-HOLE (TO-39)

IRHLF7S7214 250V, N-CHANNEL

R7™ TECHNOLOGY

Product Summary

Part Number	Radiation Level	$R_{DS(on)}$	I_D
IRHLF7S7214	100K Rads (Si)	1.0Ω	3.3A
IRHLF7S3214	300K Rads (Si)	1.0Ω	3.3A

TO-39

International Rectifier's R7™ Logic Level Power MOSFETs provide simple solution to interfacing CMOS and TTL control circuits to power devices in space and other radiation environments.The threshold voltage remains within acceptable operating limits over the full operating temperature and post radiation.This is achieved while maintaining single event gate rupture and single event burnout immunity.

The device is ideal when used to interface directly with most logic gates, linear IC's, micro-controllers, and other device types that operate from a 3.3-5V source. It may also be used to increase the output current of a PWM, voltage comparator or an operational amplifier where the logic level drive signal is available.

Features:

- 5V CMOS and TTL Compatible
- Fast Switching
- Single Event Effect (SEE) Hardened
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Light Weight
- ESD Rating: Class 1B per MIL-STD-750, Method 1020

Absolute Maximum Ratings — Pre-Irradiation

	Parameter		Units
I_D @ V_{GS} = 4.5V, T_C=25°C	Continuous Drain Current	3.3	A
I_D @ V_{GS} = 4.5V, T_C=100°C	Continuous Drain Current	2.1	
I_{DM}	Pulsed Drain Current ①	13.2	
P_D @ T_C = 25°C	Max. Power Dissipation	22.7	W
	Linear Derating Factor	0.18	W/°C
V_{GS}	Gate-to-Source Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	29	mJ
I_{AR}	Avalanche Current ①	3.3	A
E_{AR}	Repetitive Avalanche Energy ①	2.3	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.29	V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	-55 to 150	°C
	Lead Temperature	300 (0.063in/1.6mm from case for 10s)	
	Weight	0.98 (Typical)	g

For footnotes refer to the last page

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

	Parameter	Min	Typ	Max	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	—	—	V	V_{GS} = 0V, I_D = 250µA
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.22	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	1.0	Ω	V_{GS} = 4.5V, I_D = 2.1A ④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	—	2.0	V	V_{DS} = V_{GS}, I_D = 250µA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	—	-5.2	—	mV/°C	
g_{fs}	Forward Transconductance	2.5	—	—	S	V_{DS} = 15V, I_{DS} = 2.1A ④
I_{DSS}	Zero Gate Voltage Drain Current	—	—	1.0	µA	V_{DS}= 200V ,V_{GS} = 0V
		—	—	10		V_{DS} = 200V, V_{GS} = 0V, T_J =125°C
I_{GSS}	Gate-to-Source Leakage Forward	—	—	100	nA	V_{GS} = 10V
I_{GSS}	Gate-to-Source Leakage Reverse	—	—	-100		V_{GS} = -10V
Q_g	Total Gate Charge	—	—	18	nC	V_{GS} = 4.5V, I_D = 3.3A
Q_{gs}	Gate-to-Source Charge	—	—	5.0		V_{DS} = 125V
Q_{gd}	Gate-to-Drain ('Miller') Charge	—	—	12		
$t_{d(on)}$	Turn-On Delay Time	—	—	27	ns	V_{DD} = 125V, I_D = 3.3A,
t_r	Rise Time	—	—	57		V_{GS} = 5.0V, R_G = 7.5Ω
$t_{d(off)}$	Turn-Off Delay Time	—	—	45		
t_f	Fall Time	—	—	55		
$L_S + L_D$	Total Inductance	—	7.0	—	nH	Measured from Drain lead (6mm /0.25in from pack.) to Source lead (6mm/0.25in from pack.)with Source wire internally bonded from Source pin to Drain pad
C_{iss}	Input Capacitance	—	611	—	pF	V_{GS} = 0V, V_{DS} = 25V
C_{oss}	Output Capacitance	—	62	—		f = 1.0MHz
C_{rss}	Reverse Transfer Capacitance	—	0.64	—		
R_g	Gate Resistance	—	8.0	—	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)	—	—	3.3	A	
I_{SM}	Pulse Source Current (Body Diode) ➀	—	—	13.2		
V_{SD}	Diode Forward Voltage	—	—	1.2	V	T_j = 25°C, I_S = 3.3A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	371	ns	T_j = 25°C, I_F = 3.3A, di/dt ≤ 100A/µs
Q_{RR}	Reverse Recovery Charge	—	—	1.05	µC	V_{DD} ≤ 25V ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R_{thJC}	Junction-to-Case	—	—	5.5	°C/W	

Note: Corresponding Spice and Saber models are available on International Rectifier Web site.

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-39 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 300K Rads(Si)[1]		Units	Test Conditions
		Min	Max		
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	—	V	V_{GS} = 0V, I_D = 250µA
$V_{GS(th)}$	Gate Threshold Voltage	1.0	2.0		V_{GS} = V_{DS}, I_D = 250µA
I_{GSS}	Gate-to-Source Leakage Forward	—	100	nA	V_{GS} = 10V
I_{GSS}	Gate-to-Source Leakage Reverse	—	-100		V_{GS} = -10V
I_{DSS}	Zero Gate Voltage Drain Current	—	1.0	µA	V_{DS}= 200V, V_{GS}= 0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-39)	—	1.0	Ω	V_{GS} = 4.5V, I_D = 2.1A
V_{SD}	Diode Forward Voltage ④	—	1.2	V	V_{GS} = 0V, I_D = 3.3A

1. Part numbers IRHLF7S7214, IRHLF7S3214

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. Typical Single Event Effect Safe Operating Area

ION	LET (MeV/(mg/cm^2))	Energy (MeV)	Range (µm)	VDS (V)					
				@VGS= 0V	@VGS= -1V	@VGS= -2V	@VGS= -5V	@VGS= -6V	@VGS= -7V
Kr	34.1	573	69.6	250	250	250	250	250	250
Xe	56.8	1010	79.7	250	250	250	-	-	-

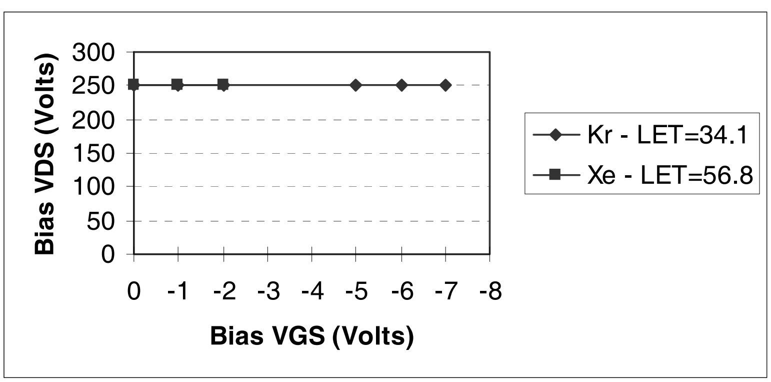


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the last page

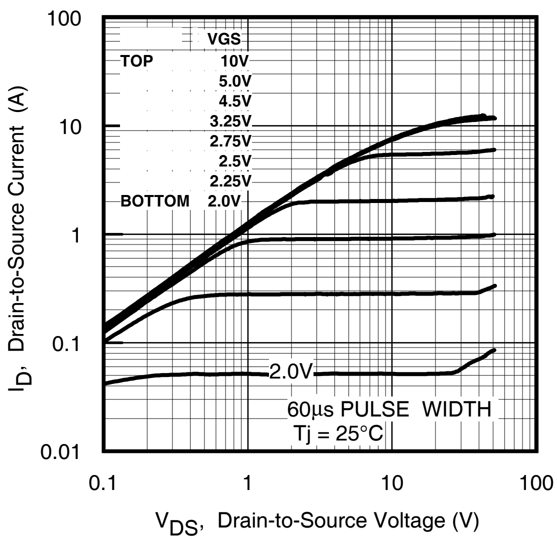


Fig 1. Typical Output Characteristics

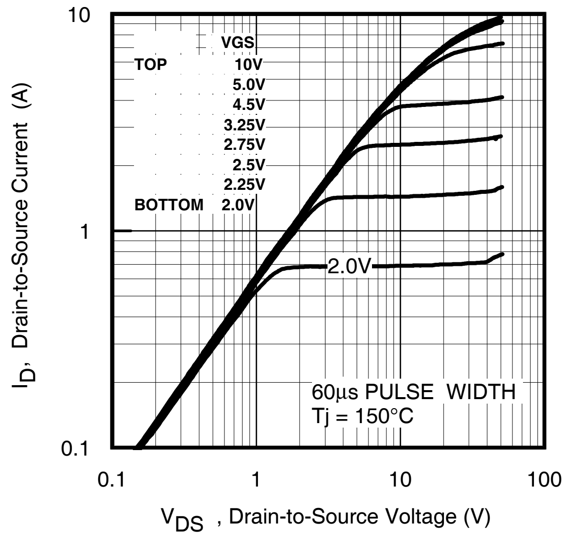


Fig 2. Typical Output Characteristics

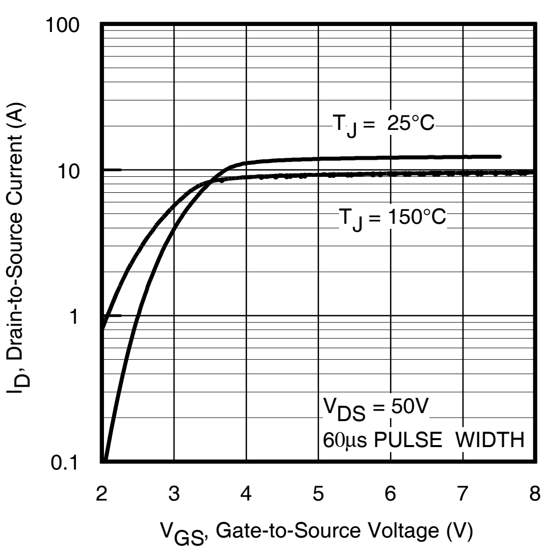


Fig 3. Typical Transfer Characteristics

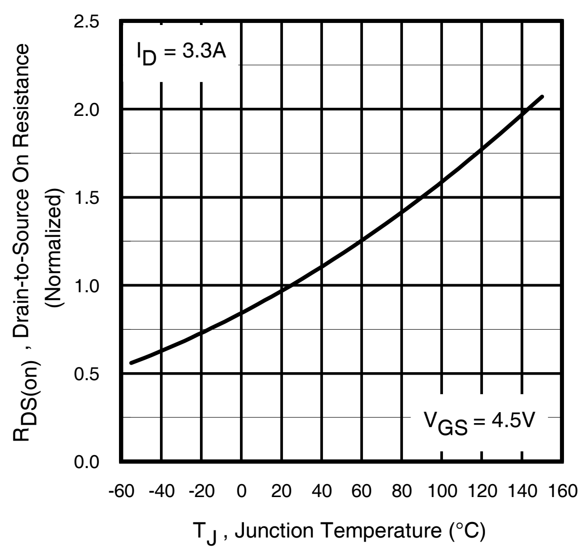


Fig 4. Normalized On-Resistance Vs. Temperature

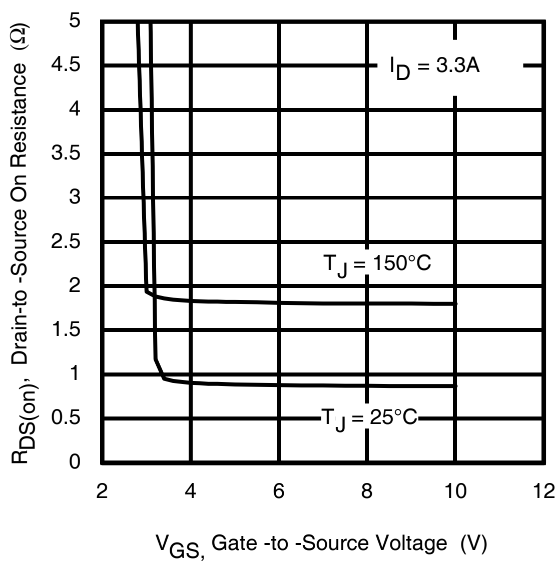


Fig 5. Typical On-Resistance Vs Gate Voltage

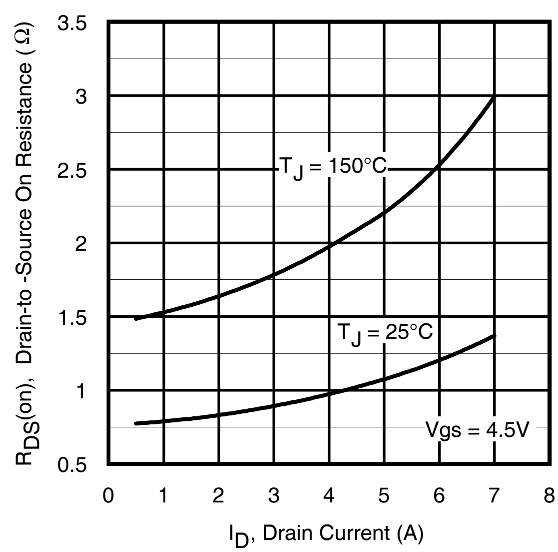


Fig 6. Typical On-Resistance Vs Drain Current

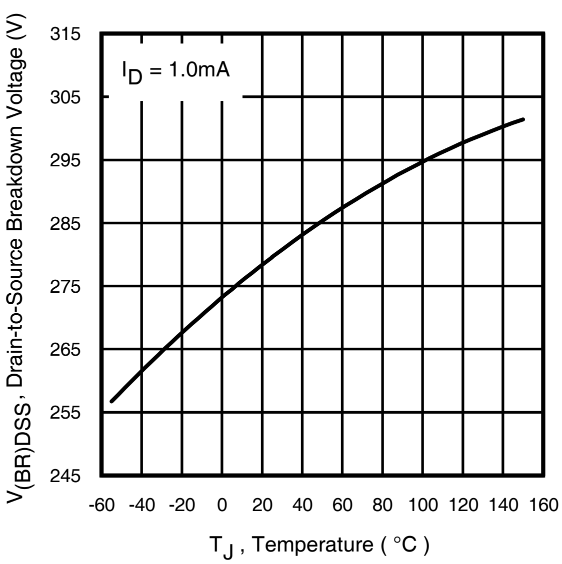


Fig 7 Typical Drain-to-Source Breakdown Voltage Vs Temperature

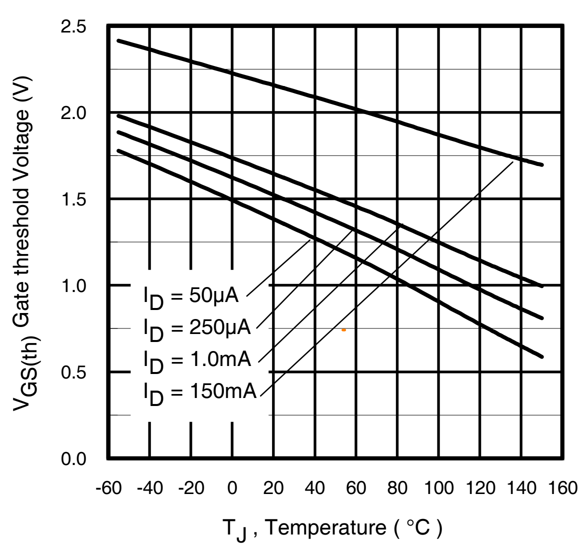


Fig 8. Typical Threshold Voltage Vs Temperature

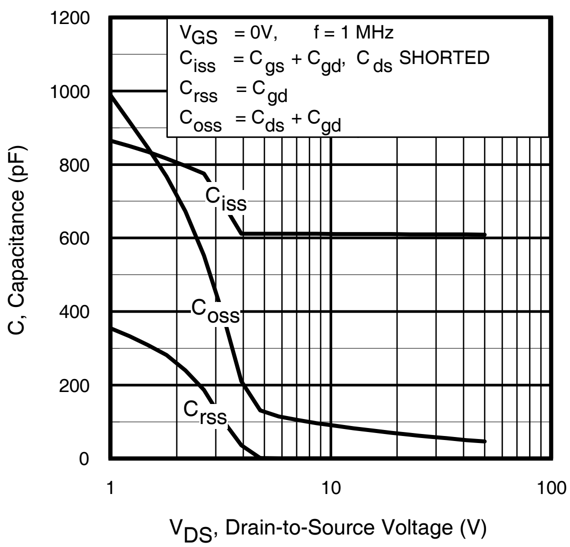


Fig 9. Typical Capacitance Vs. Drain-to-Source Voltage

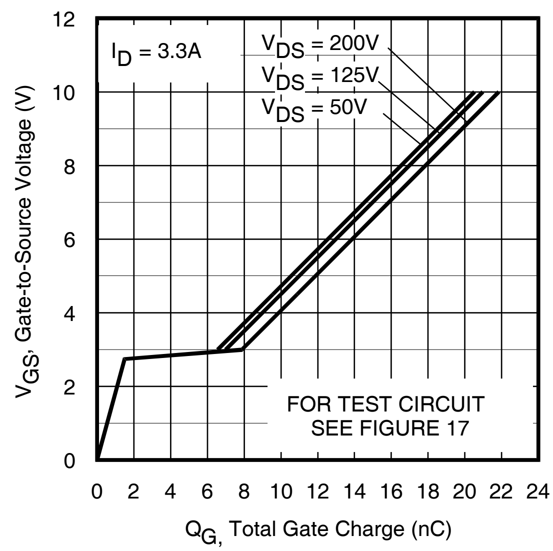


Fig 10. Typical Gate Charge Vs. Gate-to-Source Voltage

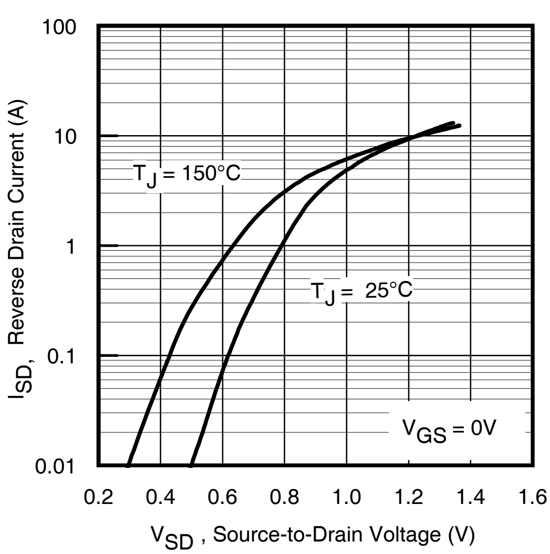


Fig 11. Typical Source-to-Drain Diode Forward Voltage

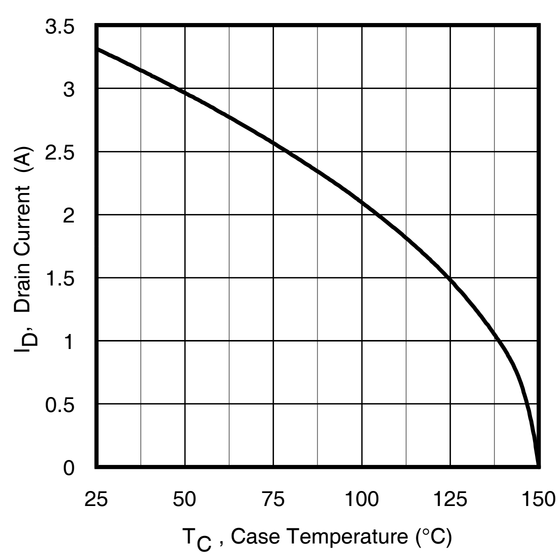


Fig 12. Maximum Drain Current Vs. Case Temperature

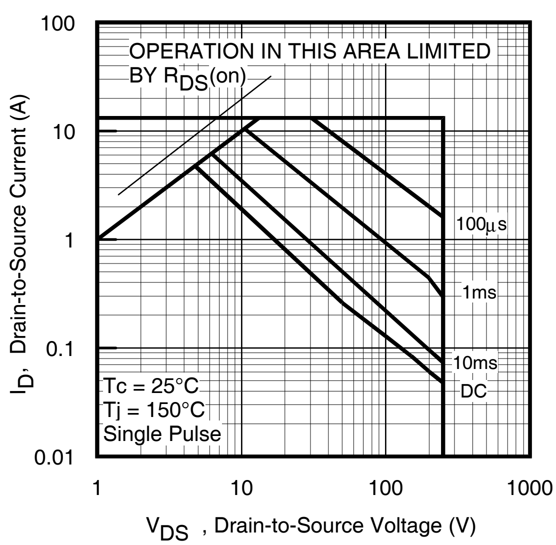


Fig 13. Maximum Safe Operating Area

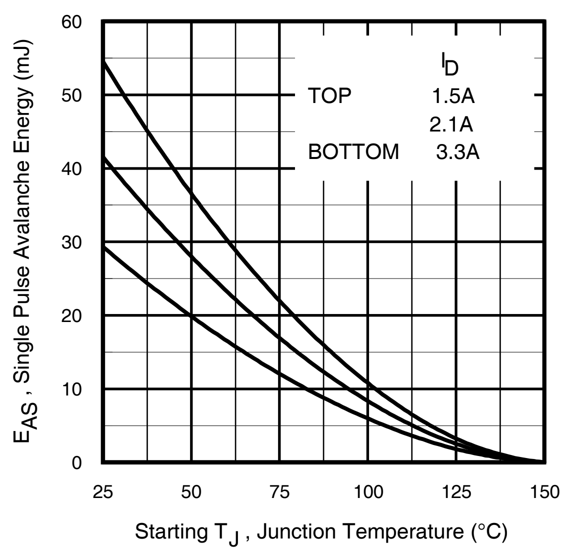


Fig 14. Maximum Avalanche Energy Vs. Drain Current

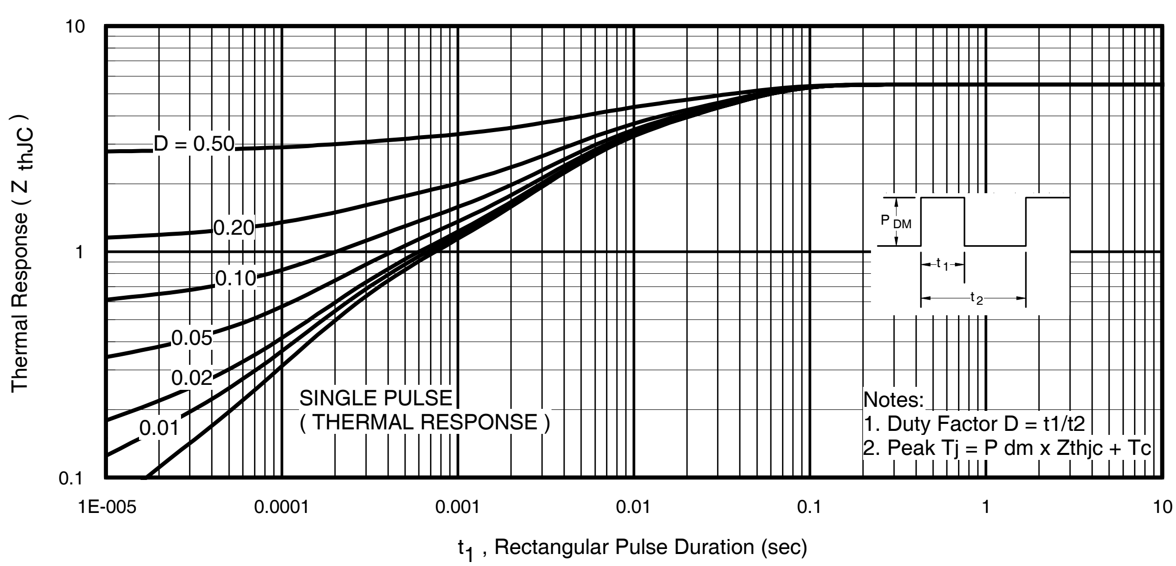


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

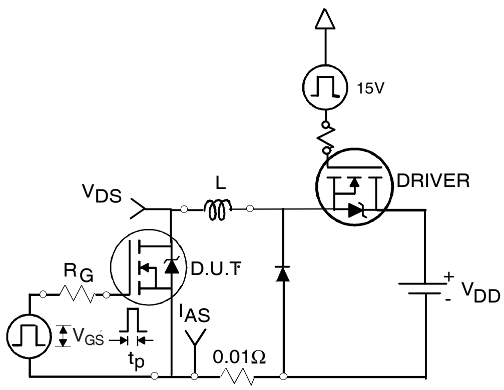


Fig 16a. Unclamped Inductive Test Circuit

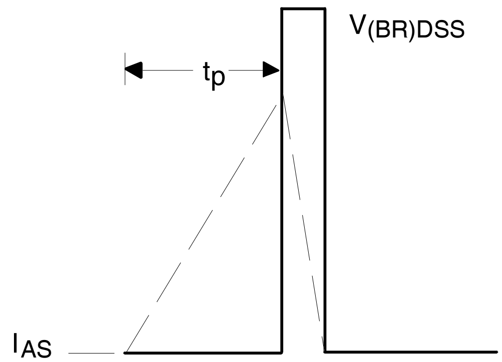


Fig 16b. Unclamped Inductive Waveforms

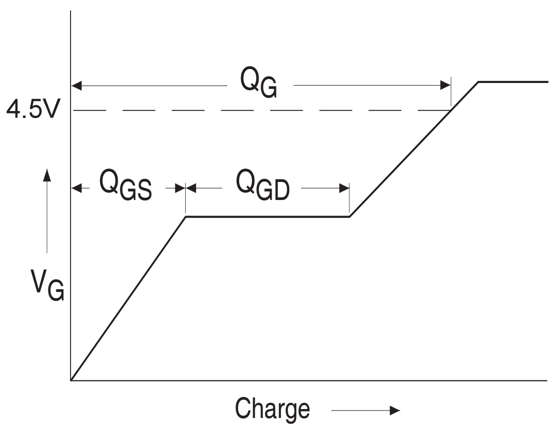


Fig 17a. Basic Gate Charge Waveform

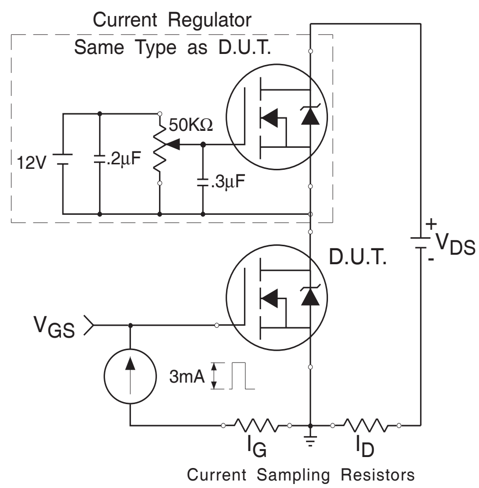


Fig 17b. Gate Charge Test Circuit

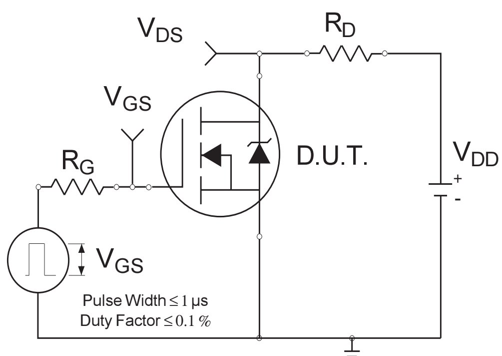


Fig 18a. Switching Time Test Circuit

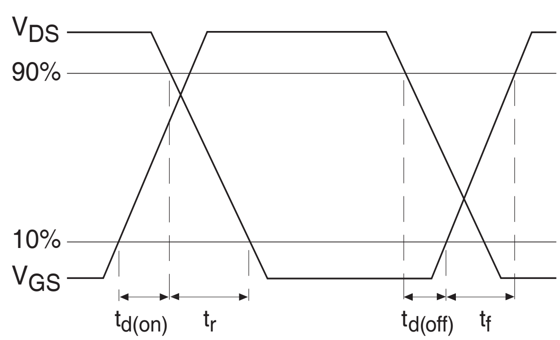
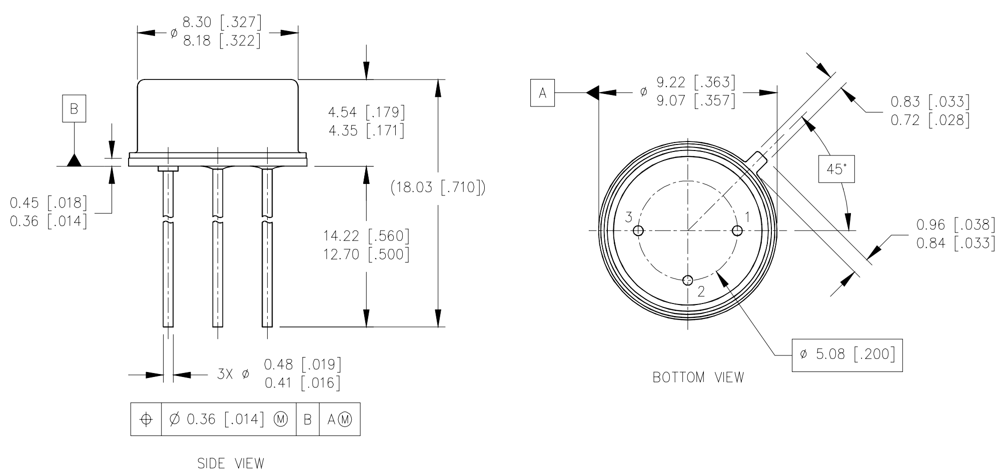


Fig 18b. Switching Time Waveforms

Footnotes:

① Repetitive Rating; Pulse width limited by maximum junction temperature.
② V_{DD} = 50V, starting T_J = 25°C, L = 5.4mH Peak I_L = 3.3A, V_{GS} = 10V
③ I_{SD} ≤ 3.3A, di/dt ≤ 372A/µs, V_{DD} ≤ 250V, T_J ≤ 150°C
④ Pulse width ≤ 300 µs; Duty Cycle ≤ 2%
⑤ **Total Dose Irradiation with V_{GS} Bias.** 10 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.** 200 volt V_{DS} applied and V_{GS} = 0 during irradiation per MIL-STD-750, method 1019, condition A.

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



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

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