PRELIMINARY

PD-97177B

International
IOR Rectifier

RADIATION HARDENED LOGIC LEVEL POWER MOSFET SURFACE MOUNT (SMD-2)

2N7604U2
IRHLNA77064
60V, N-CHANNEL
R7™ TECHNOLOGY

Product Summary

Part Number	Radiation Level	$R_{DS(on)}$	I_D
IRHLNA77064	100K Rads (Si)	0.012Ω	56A*
IRHLNA73064	300K Rads (Si)	0.012Ω	56A*

SMD-2

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.

These devices are used in applications such as current boost low signal source in PWM, voltage comparator and operational amplifiers.

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
- Ceramic Package
- Surface Mount
- Light Weight

Absolute Maximum Ratings

Pre-Irradiation

	Parameter		Units
I_D @ V_{GS} = 4.5V, T_C = 25°C	Continuous Drain Current	56*	A
I_D @ V_{GS} = 4.5V, T_C = 100°C	Continuous Drain Current	56*	
I_{DM}	Pulsed Drain Current ①	224	
P_D @ T_C = 25°C	Max. Power Dissipation	250	W
	Linear Derating Factor	2.0	W/°C
V_{GS}	Gate-to-Source Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	402	mJ
I_{AR}	Avalanche Current ①	56	A
E_{AR}	Repetitive Avalanche Energy ①	25	mJ
dv/dt	Peak Diode Recovery dv/dt ③	6.9	V/ns
T_J	Operating Junction	-55 to 150	°C
T_{STG}	Storage Temperature Range		
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	3.3 (Typical)	g

* Current is limited by package

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	60	—	—	V	V_{GS} = 0V, I_D = 250μA
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.07	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.012	Ω	V_{GS} = 4.5V, I_D = 56A 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	—	-6.6	—	mV/°C	
g_{fs}	Forward Transconductance	32	—	—	S	V_{DS} = 10V, I_{DS} = 56A ④
I_{DSS}	Zero Gate Voltage Drain Current	—	—	1.0	μA	V_{DS}= 48V ,V_{GS}=0V
		—	—	10		V_{DS} = 48V, 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	—	—	151	nC	V_{GS} = 4.5V, I_D = 56A
Q_{gs}	Gate-to-Source Charge	—	—	30		V_{DS} = 30V
Q_{gd}	Gate-to-Drain ('Miller') Charge	—	—	70		
$t_{d(on)}$	Turn-On Delay Time	—	—	51	ns	V_{DD} = 30V, I_D = 56A, V_{GS} = 4.5V, R_G = 2.35Ω
t_r	Rise Time	—	—	170		
$t_{d(off)}$	Turn-Off Delay Time	—	—	110		
t_f	Fall Time	—	—	17		
$L_S + L_D$	Total Inductance	—	4.0	—	nH	Measured from the center of drain pad to center of source pad
Ciss	Input Capacitance	—	10220	—	pF	V_{GS} = 0V, V_{DS} = 25V
C_{oss}	Output Capacitance	—	2343	—		f = 100KHz
C_{rss}	Reverse Transfer Capacitance	—	40	—		
R_g	Gate Resistance	—	0.56	—	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)	—	—	56*	A	
I_{SM}	Pulse Source Current (Body Diode) ①	—	—	224		
V_{SD}	Diode Forward Voltage	—	—	1.2	V	T_j = 25°C, I_S = 56A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	214	ns	T_j = 25°C, I_F =56A, di/dt ≤ 100A/μs
Q_{RR}	Reverse Recovery Charge	—	—	1.16	μC	V_{DD} ≤ 30V ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

* Current is limited by package

Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R_{thJC}	Junction-to-Case	—	—	0.5	°C/W	
$R_{thJ\text{-}PCB}$	Junction-to-PC board	—	1.6	—		soldered to a 2" square copper-cladboard

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-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	Upto 300K Rads (Si)[1]		Units	Test Conditions ⑧
		Min	Max		
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	—	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	—	10	µA	V_{DS}= 48V, V_{GS}=0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.01	Ω	V_{GS} = 4.5V, I_D = 56A
$R_{DS(on)}$	Static Drain-to-Source On-state ④ Resistance (SMD-2)	—	0.012	Ω	V_{GS} = 4.5V, I_D = 56A
V_{SD}	Diode Forward Voltage④	—	1.2	V	V_{GS} = 0V, I_D = 56A

1. Part numbers IRHLNA77064, IRHLNA73064

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	Energy	Range	VDS (V)								
	(MeV/(mg/cm^2))	(MeV)	(µm)	@VGS= 0V	@VGS= -3V	@VGS= -4V	@VGS= -5V	@VGS= -6V	@VGS= -7V	@VGS= -8V	@VGS= -9V	@VGS= -10V
Br	37	305	39	60	60	50	45	40	30	25	20	15
I	60	370	34	60	60	60	60	30	20	10	10	-
Au	84	390	30	60	60	60	50	25	-		-	-

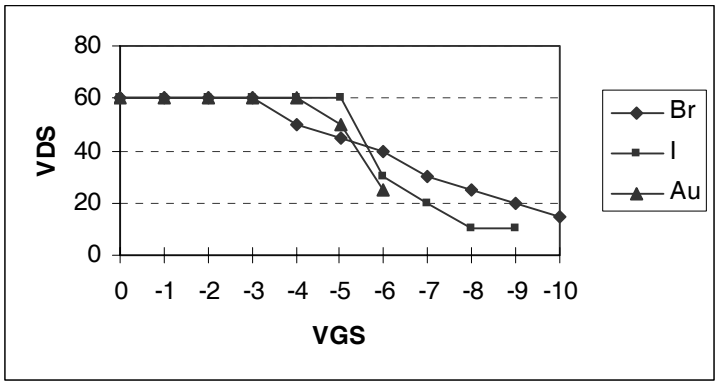


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the last page

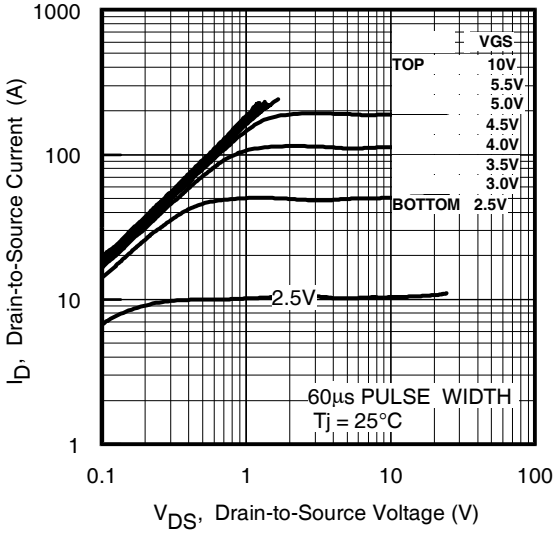


Fig 1. Typical Output Characteristics

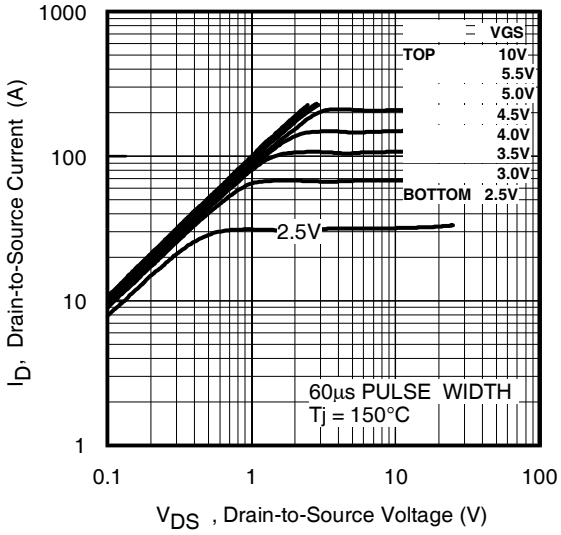


Fig 2. Typical Output Characteristics

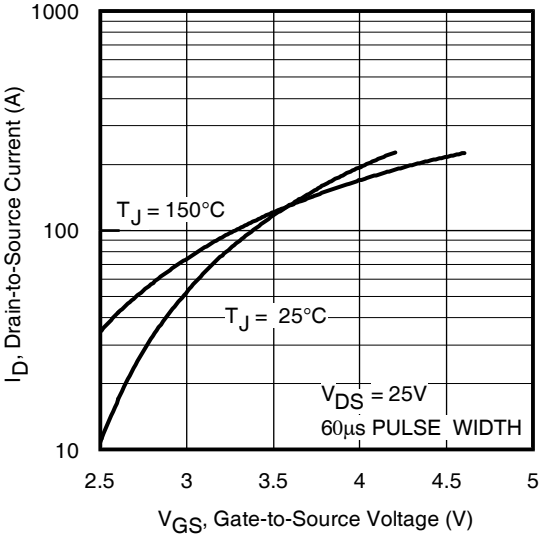


Fig 3. Typical Transfer Characteristics

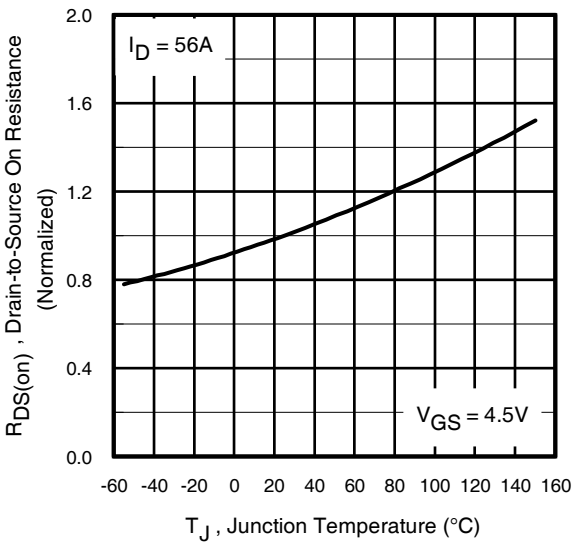


Fig 4. Normalized On-Resistance Vs. Temperature

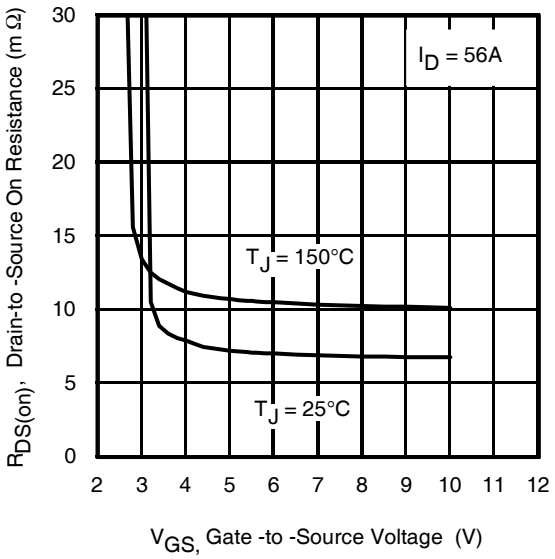


Fig 5. Typical On-Resistance Vs Gate Voltage

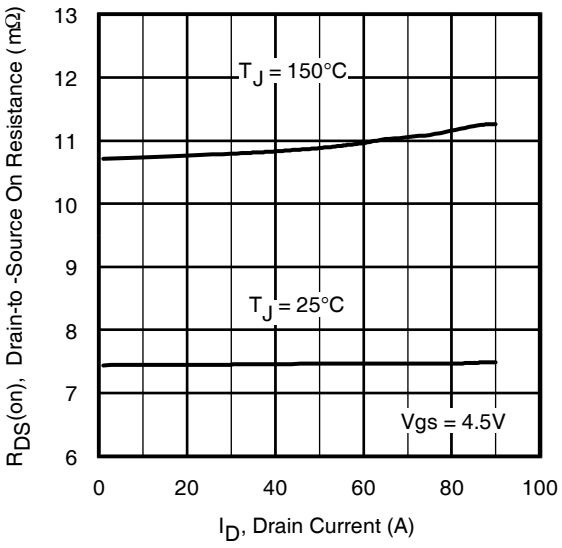


Fig 6. Typical On-Resistance Vs Drain Current

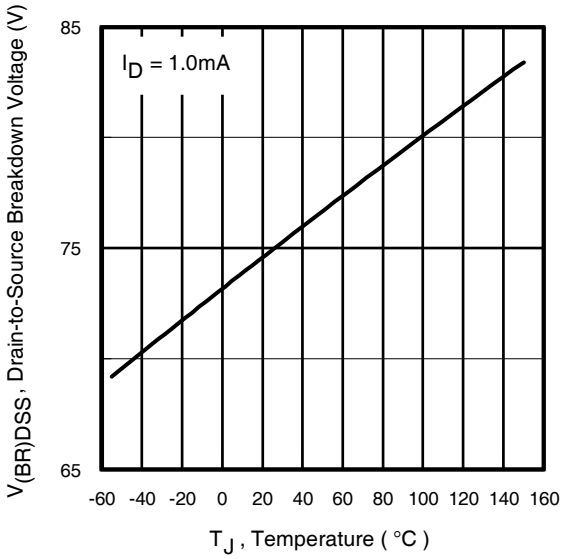


Fig 7. Typical Drain-to-Source Breakdown Voltage Vs Temperature

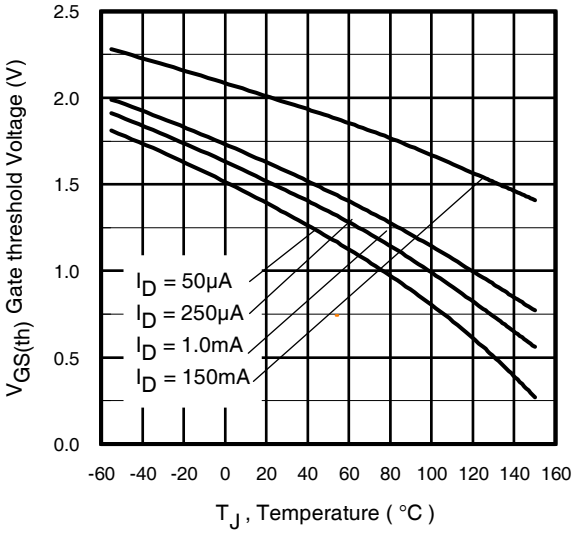


Fig 8. Typical Threshold Voltage Vs Temperature

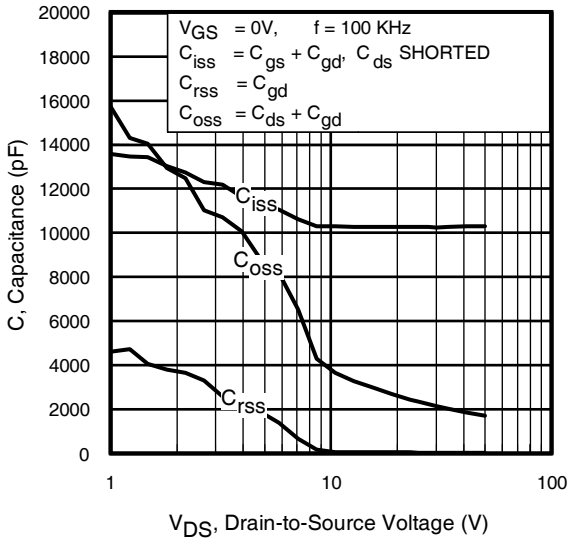


Fig 9. Typical Capacitance Vs. Drain-to-Source Voltage

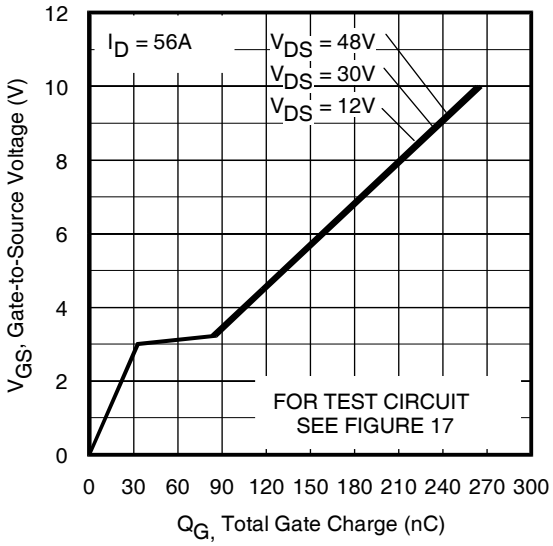


Fig 10. Typical Gate Charge Vs. Gate-to-Source Voltage

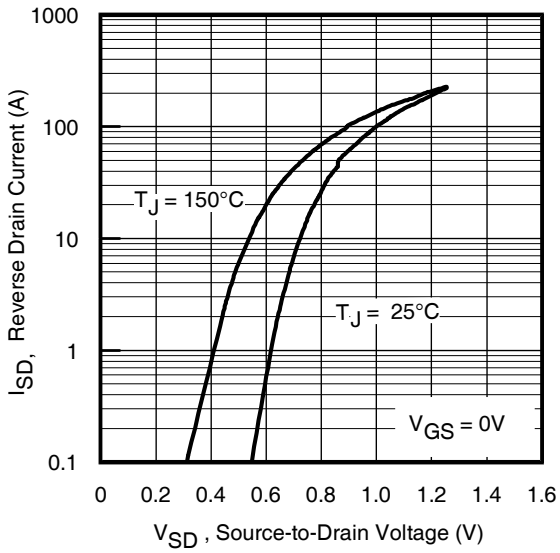


Fig 11. Typical Source-to-Drain Diode Forward Voltage

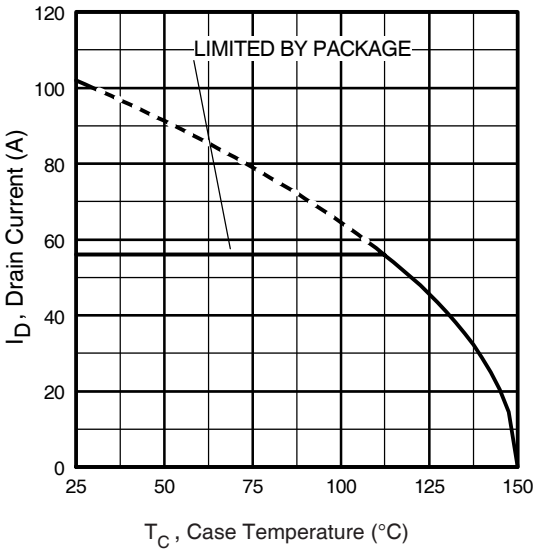


Fig 12. Maximum Drain Current Vs. Case Temperature

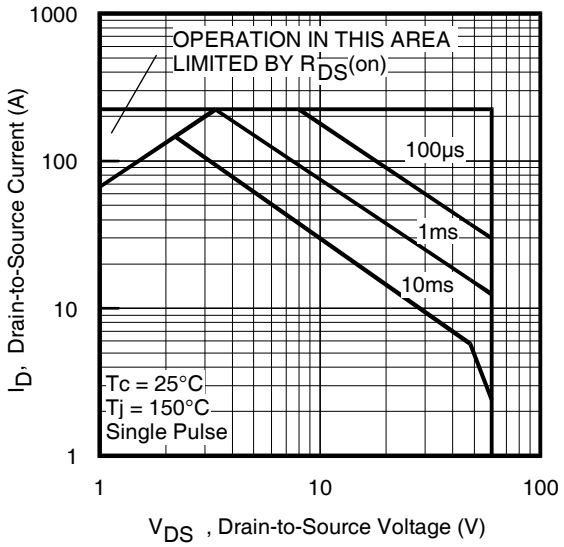


Fig 13. Maximum Safe Operating Area

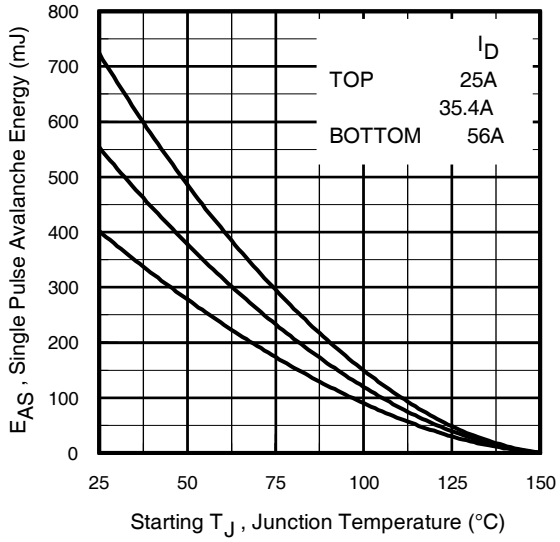


Fig 14. Maximum Avalanche Energy Vs. Drain Current

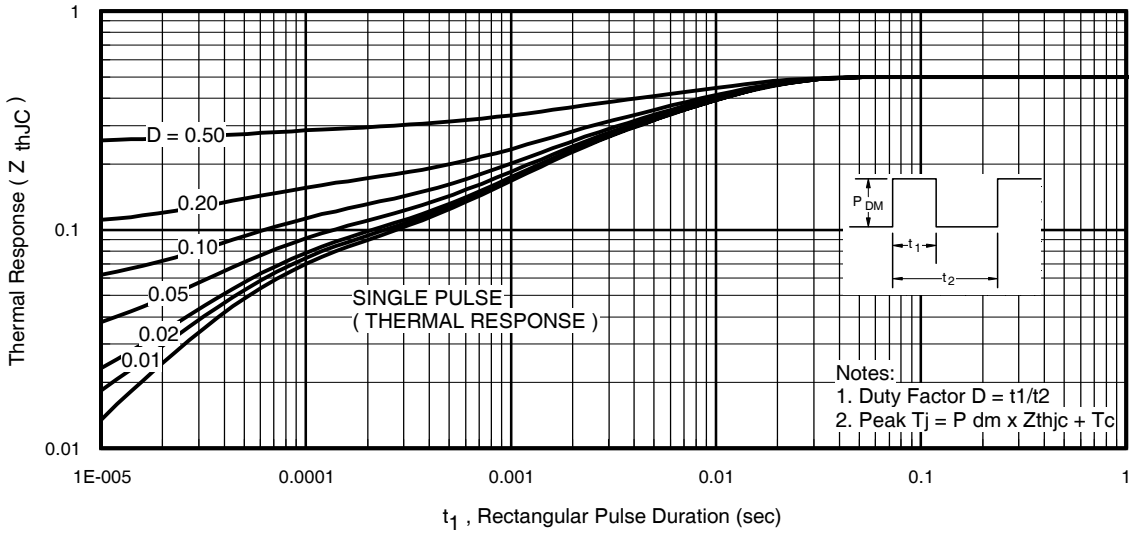


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

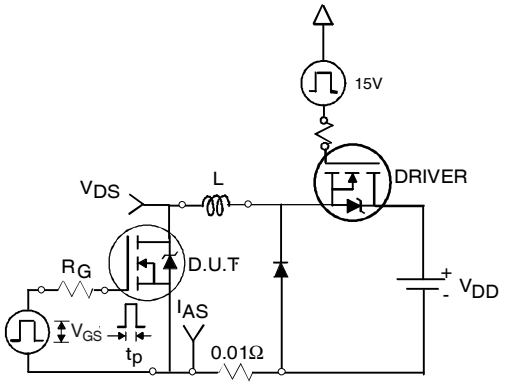


Fig 16a. Unclamped Inductive Test Circuit

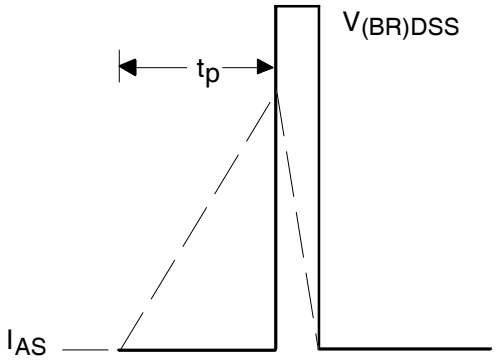


Fig 16b. Unclamped Inductive Waveforms

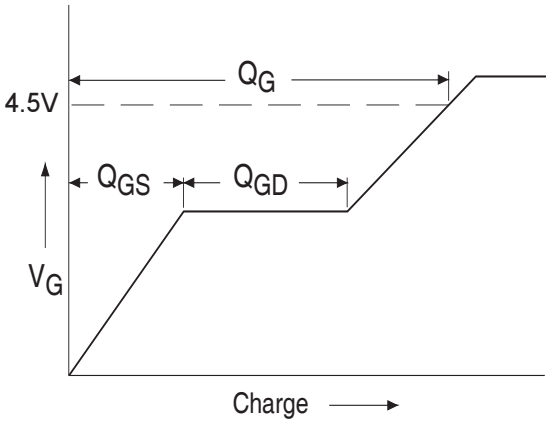


Fig 17a. Basic Gate Charge Waveform

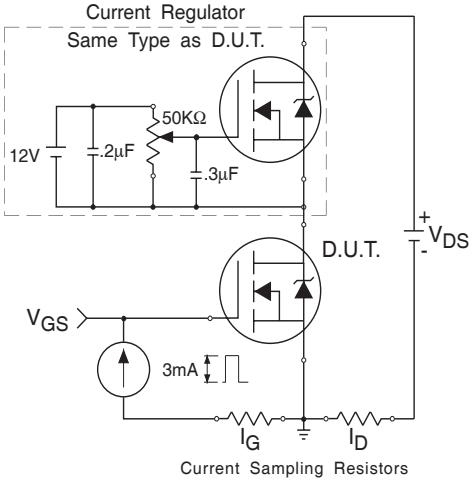


Fig 17b. Gate Charge Test Circuit

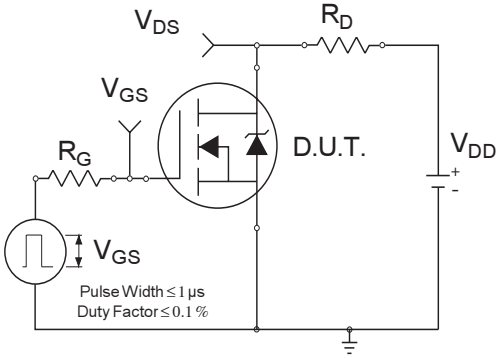


Fig 18a. Switching Time Test Circuit

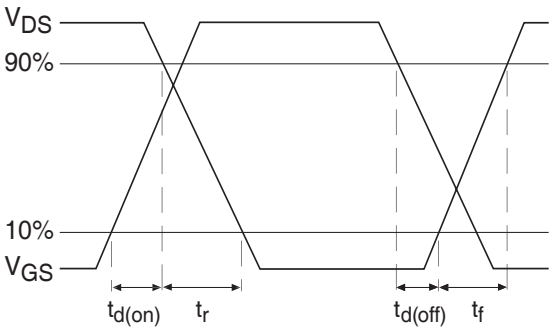


Fig 18b. Switching Time Waveforms

Footnotes:

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

② V_{DD} = 25V, starting T_J = 25°C, L= 0.26mH Peak I_L = 56A, V_{GS} = 10V

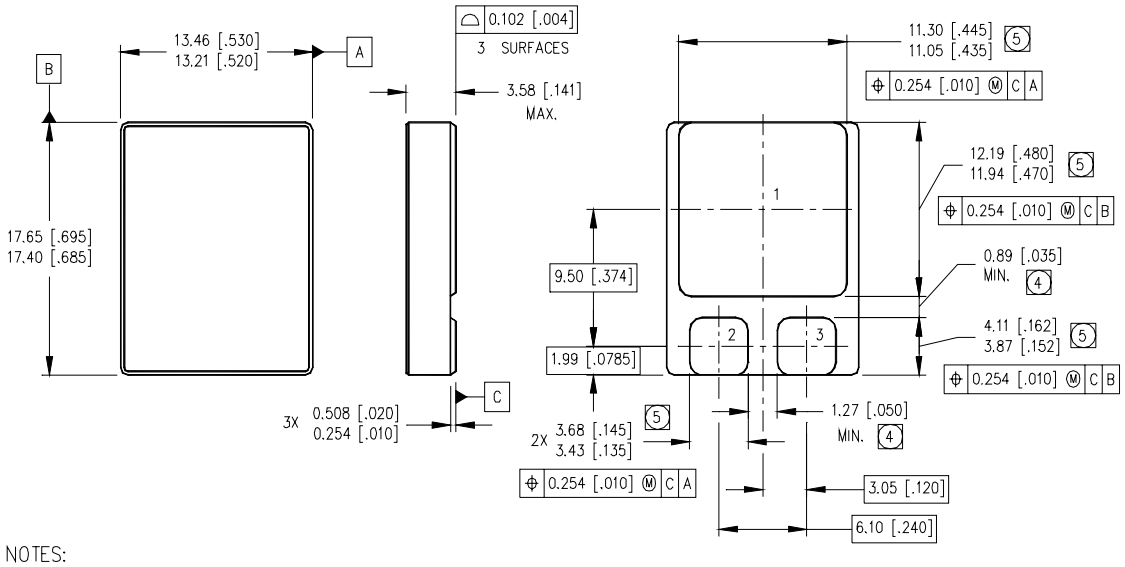
③ $I_{SD} \leq 56A$, $di/dt \leq 350A/\mu s$, $V_{DD} \leq 60V$, $T_J \leq 150°C$

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.** 48 volt V_{DS} applied and V_{GS} = 0 during irradiation per MIL-STD-750, method 1019, condition A.

Case Outline and Dimensions — SMD-2



NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. DIMENSION INCLUDES METALLIZATION FLASH.
5. DIMENSION DOES NOT INCLUDE METALLIZATION FLASH.

PAD ASSIGNMENTS

1 = DRAIN
2 = GATE
3 = SOURCE

International
IOR Rectifier

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