

IRH7250

PD-90697G

Radiation Hardened Power MOSFET Thru-Hole (TO-204AE)

200V, 26A, N-channel, Rad Hard HEXFET™ Technology

Features

- Single event effect (SEE) hardened
- Low $R_{DS(on)}$
- Low total gate charge
- Proton tolerant
- Simple drive requirements
- Hermetically sealed
- Ceramic package
- ESD rating: Class 3A per MIL-STD-750, Method 1020

Product Summary

- BV_{DSS} : 200V
- I_D : 26A
- $R_{DS(on),max}$: 110mΩ
- $Q_{G,max}$: 170nC



Potential Applications

- DC-DC converter
- Motor drives

Product Validation

Qualified according to MIL-PRF-19500 for space applications

Description

IR HiRel rad hard HEXFET technology provides high performance power MOSFETs for space applications. This technology has over a decade 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 $R_{DS(on)}$ 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.

Ordering Information

Table 1 Ordering options

Part number	Package	Screening Level	TID Level
IRH7250	TO-204AE	COTS	100 krad(Si)
IRH3250	TO-204AE	COTS	300 krad(Si)
IRH4250	TO-204AE	COTS	500 krad(Si)

Table of contents

Table of contents

Features	1
Potential Applications.....	1
Product Validation.....	1
Description	1
Ordering Information.....	1
Table of contents.....	2
1 Absolute Maximum Ratings	3
2 Device Characteristics	4
2.1 Electrical Characteristics (Pre-Irradiation).....	4
2.2 Source-Drain Diode Ratings and Characteristics (Pre-Irradiation)	5
2.3 Thermal Characteristics	5
2.4 Radiation Characteristics.....	5
2.4.1 Electrical Characteristics — Post Total Dose Irradiation	5
2.4.2 Single Event Effects — Safe Operating Area	6
3 Electrical Characteristics Curves (Pre-irradiation)	7
4 Test Circuits (Pre-irradiation)	10
5 Package Outline.....	11
Revision history.....	12

Absolute Maximum Ratings

1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings (Pre-Irradiation)

Symbol	Parameter	Value	Unit
$I_{D1} @ V_{GS} = 12V, T_C = 25^{\circ}C$	Continuous Drain Current	26	A
$I_{D2} @ V_{GS} = 12V, T_C = 100^{\circ}C$	Continuous Drain Current	16	A
$I_{DM} @ T_C = 25^{\circ}C$	Pulsed Drain Current ¹	104	A
$P_D @ T_C = 25^{\circ}C$	Maximum Power Dissipation	150	W
	Linear Derating Factor	1.2	W/ $^{\circ}C$
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy ²	500	mJ
I_{AR}	Avalanche Current ¹	26	A
E_{AR}	Repetitive Avalanche Energy ¹	15	mJ
dv/dt	Peak Diode Reverse Recovery ³	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	$^{\circ}C$
	Lead Temperature	300 (0.063 in. /1.6 mm from case for 10s)	
	Weight	11.5 (Typical)	

¹ Repetitive Rating; Pulse width limited by maximum junction temperature.² $V_{DD} = 25V$, starting $T_J = 25^{\circ}C$, $L = 1.48mH$, Peak $I_L = 26A$, $V_{GS} = 12V$ ³ $I_{SD} \leq 26A$, $di/dt \leq 190A/\mu s$, $V_{DD} \leq 200V$, $T_J \leq 150^{\circ}C$

Device Characteristics

2 Device Characteristics

2.1 Electrical Characteristics (Pre-Irradiation)

Table 3 Static and Dynamic Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (Unless Otherwise Specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	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	—	0.27	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = 1.0mA$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	100	$m\Omega$	$V_{GS} = 12V, I_{D2} = 16A^1$
		—	—	110		$V_{GS} = 12V, I_{D1} = 26A^1$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}, I_D = 1mA$
G_{fs}	Forward Transconductance	8.0	—	—	S	$V_{DS} = 15V, I_{D2} = 16A^4$
I_{DSS}	Zero Gate Voltage Drain Current	—	—	25	μA	$V_{DS} = 160V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 160V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
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	—	—	170	nC	$I_{D1} = 26A$
Q_{GS}	Gate-to-Source Charge	—	—	30		$V_{DS} = 100V$
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	70		$V_{GS} = 12V$
$t_{d(on)}$	Turn-On Delay Time	—	—	33	ns	$I_{D1} = 26A^{**}$
t_r	Rise Time	—	—	140		$V_{DD} = 100V$
$t_{d(off)}$	Turn-Off Delay Time	—	—	140		$R_G = 2.35\Omega$
t_f	Fall Time	—	—	140		$V_{GS} = 12V$
$L_s + L_D$	Total Inductance	—	10	—	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	—	4700	—	pF	$V_{GS} = 0V$
C_{oss}	Output Capacitance	—	850	—		$V_{DS} = 25V$
C_{rss}	Reverse Transfer Capacitance	—	210	—		$f = 1.0MHz$

** Switching speed maximum limits are based on manufacturing test equipment and capability.

¹ Pulse width $\leq 300 \mu s$; Duty Cycle $\leq 2\%$

Device Characteristics

2.2 Source-Drain Diode Ratings and Characteristics (Pre-Irradiation)

Table 4 Source-Drain Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	26	A	
I _{SM}	Pulsed Source Current (Body Diode) ¹	—	—	104	A	
V _{SD}	Diode Forward Voltage	—	—	1.4	V	T _J = 25°C, I _S = 26A, V _{GS} = 0V ²
t _{rr}	Reverse Recovery Time	—	—	820	ns	T _J = 25°C, I _F = 26A, V _{DD} ≤ 50V di/dt = 100A/μs ²
Q _{rr}	Reverse Recovery Charge	—	—	12	μC	
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L _S +L _D)				

2.3 Thermal Characteristics

Table 5 Thermal Resistance

Symbol	Parameter	Min.	Typ.	Max.	Unit
$R_{\theta JC}$	Junction-to-Case	—	—	0.83	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Junction-to-Ambient (Typical Socket Mount)	—	—	30	
$R_{\theta JCS}$	Junction-to-Sink	—	0.12	—	

2.4 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 3 and 4) 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.

2.4.1 Electrical Characteristics — Post Total Dose Irradiation

Table 6 Electrical Characteristics @ $T_J = 25^\circ\text{C}$, Post Total Dose Irradiation ^{3, 4}

Symbol	Parameter	100 krad (Si) ⁵		Up to 500 krad (Si) ⁶		Unit	Test Conditions
		Min.	Max.	Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	—	200	—	V	$V_{GS} = 0\text{V}$, $I_D = 1.0\text{mA}$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	1.25	4.5	V	$V_{DS} = V_{GS}$, $I_D = 1.0\text{mA}$
I_{GSS}	Gate-to-Source Leakage Forward	—	100	—	100	nA	$V_{GS} = 20\text{V}$
	Gate-to-Source Leakage Reverse	—	-100	—	-100		$V_{GS} = -20\text{V}$
I_{DSS}	Zero Gate Voltage Drain Current	—	25	—	50	μA	$V_{DS} = 160\text{V}$, $V_{GS} = 0\text{V}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3) ²	—	100	—	155	$\text{m}\Omega$	$V_{GS} = 12\text{V}$, $I_{D2} = 16\text{A}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-204AE) ²	—	100	—	155	$\text{m}\Omega$	$V_{GS} = 12\text{V}$, $I_{D2} = 16\text{A}$
V_{SD}	Diode Forward Voltage	—	1.4	—	1.4	V	$V_{GS} = 0\text{V}$, $I_F = 26\text{A}$

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

² Pulse width $\leq 300\text{ }\mu\text{s}$; Duty Cycle $\leq 2\%$

³ Total Dose Irradiation with V_{GS} Bias. $V_{GS} = 12\text{V}$ applied and $V_{DS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.

⁴ Total Dose Irradiation with V_{DS} Bias. $V_{DS} = 160\text{V}$ applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.

⁵ Part numbers IRH7250

⁶ Part numbers IRH3250 and IRH4250

IRH7250
Radiation Hardened Power MOSFET Thru-Hole (TO-204AE)

Device Characteristics

2.4.2 Single Event Effects — Safe Operating Area

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. 1 and Table 7.

Table 7 Typical Single Event Effects Safe Operating Area

Ion	LET (MeV·cm ² /mg)	Energy (MeV)	Range (μm)	V _{DS} (V)				
				V _{GS} = 0V	V _{GS} = -5V	V _{GS} = -10V	V _{GS} = -15V	V _{GS} = -20V
Cu	28	285	43	190	180	170	125	—
Br	36.8	305	39	100	100	100	50	—

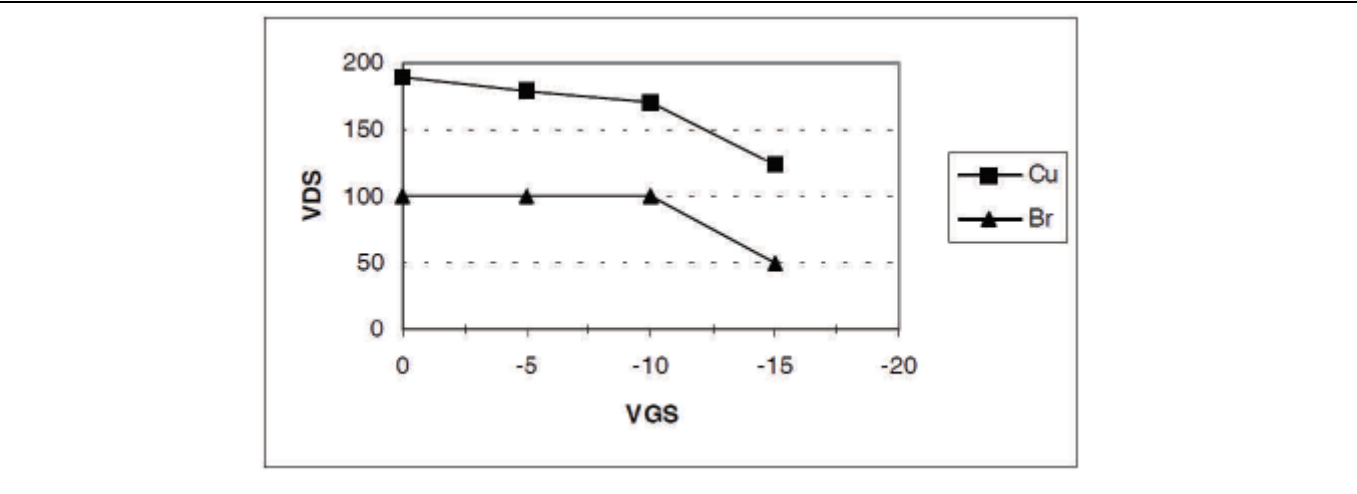


Figure 1 Typical Single Event Effect, Safe Operating Area

IRH7250

Radiation Hardened Power MOSFET Thru-Hole (TO-204AE)

Electrical Characteristics Curves (Pre-irradiation)

3 Electrical Characteristics Curves (Pre-irradiation)

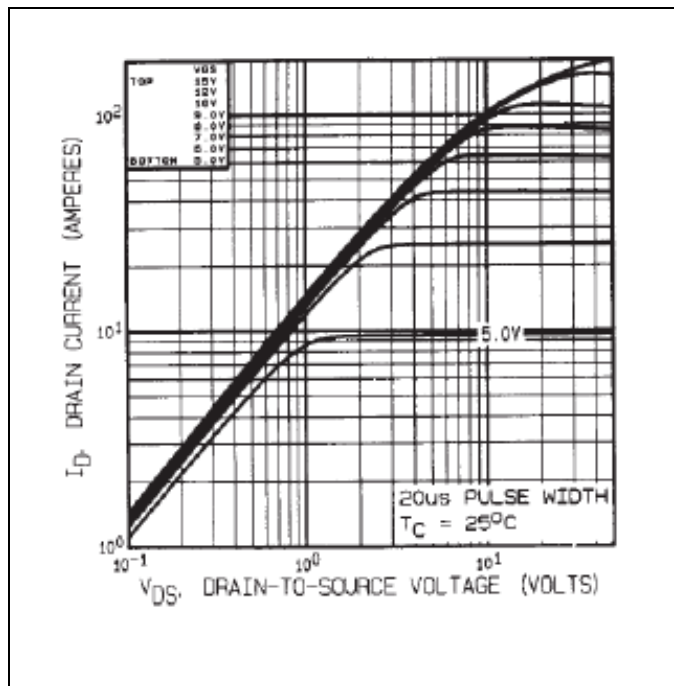


Figure 2 Typical Output Characteristics

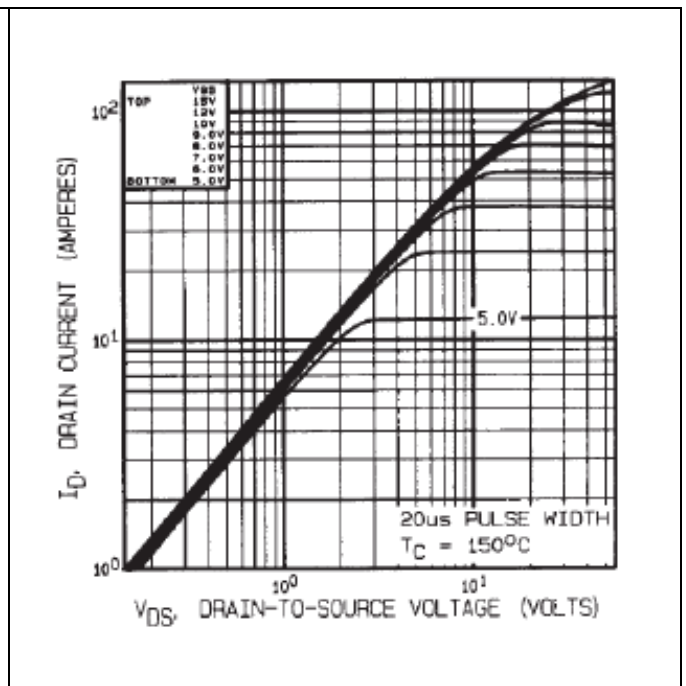


Figure 3 Typical Output Characteristics

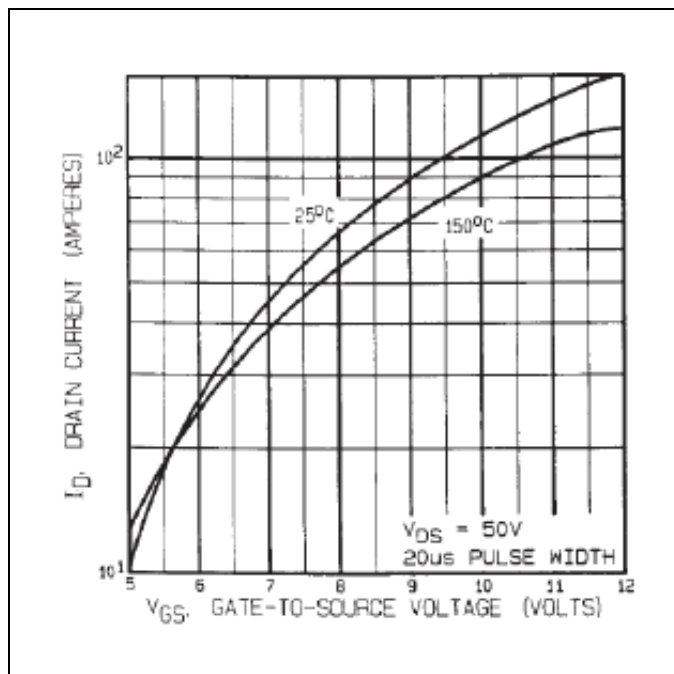


Figure 4 Typical Transfer Characteristics

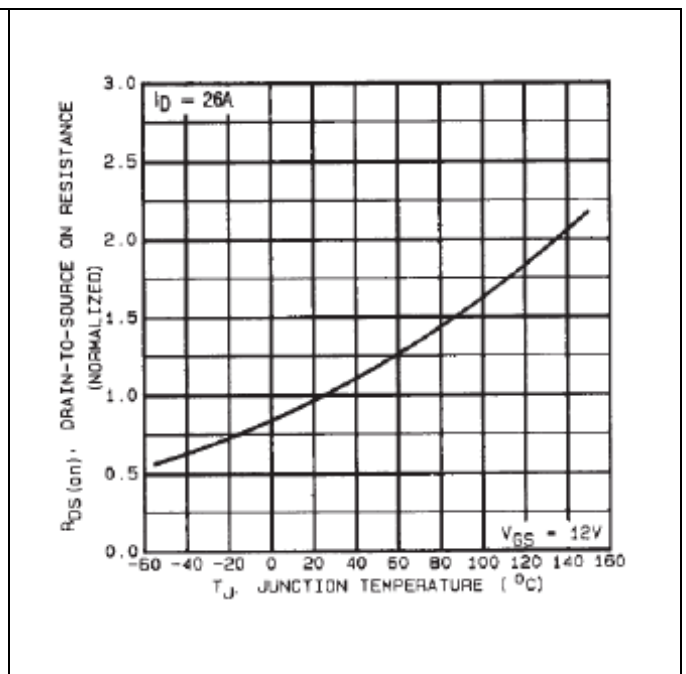


Figure 5 Normalized On-Resistance Vs. Temperature

IRH7250

Radiation Hardened Power MOSFET Thru-Hole (TO-204AE)

Electrical Characteristics Curves (Pre-irradiation)

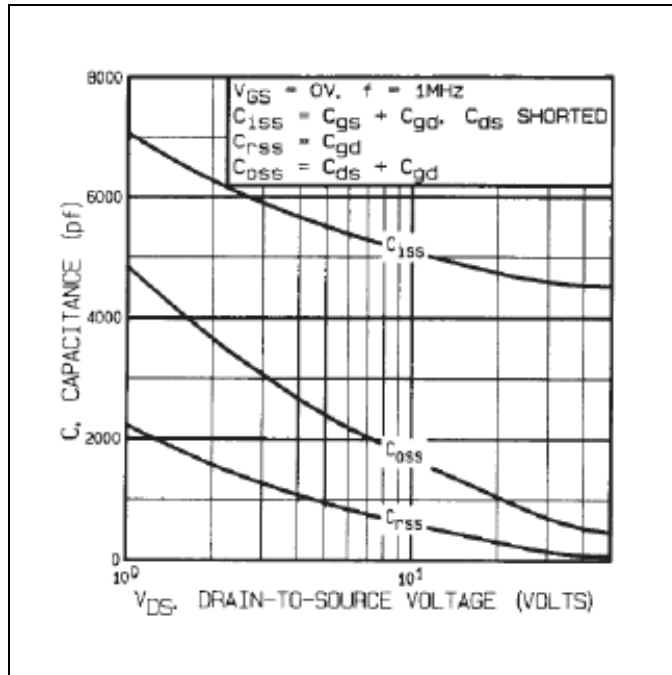


Figure 6 Typical Capacitance Vs. Drain-to-Source Voltage

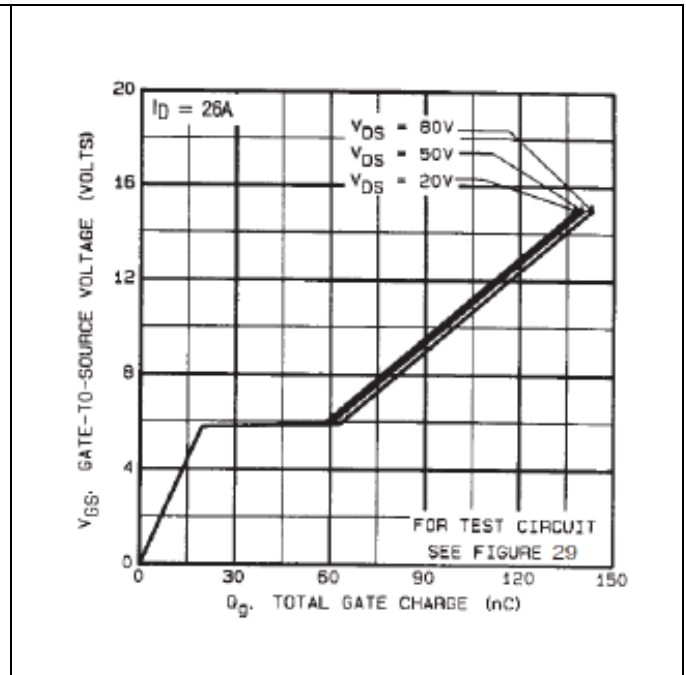


Figure 7 Typical Gate-to-Source Voltage Vs. Typical Gate Charge

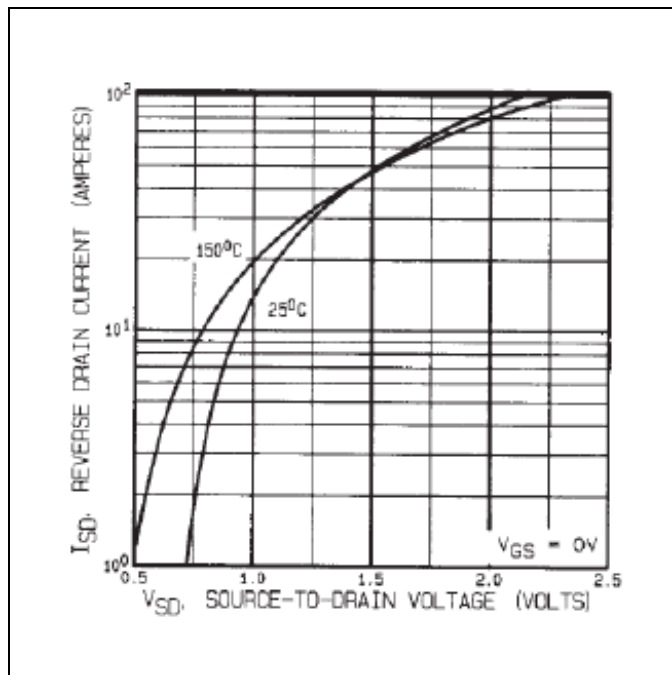


Figure 8 Typical Source-Drain Current Vs. Diode Forward Voltage

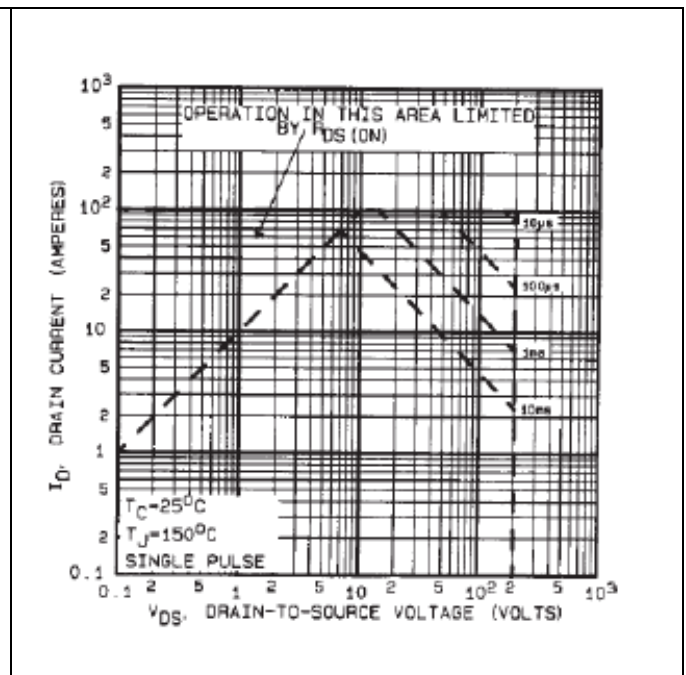


Figure 9 Maximum Safe Operating Area

IRH7250

Radiation Hardened Power MOSFET Thru-Hole (TO-204AE)

Electrical Characteristics Curves (Pre-irradiation)

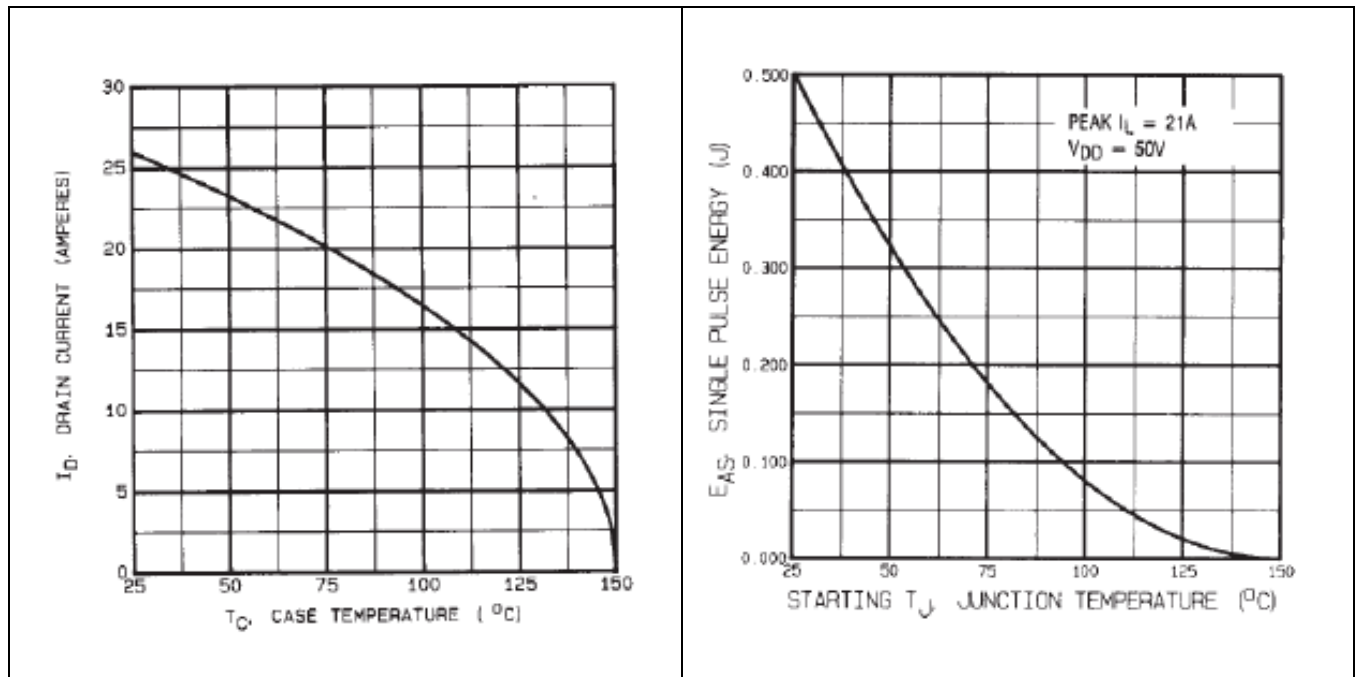


Figure 10 Maximum Drain Current Vs. Case Temperature

Figure 11 Maximum Avalanche Energy Vs. Junction Temperature

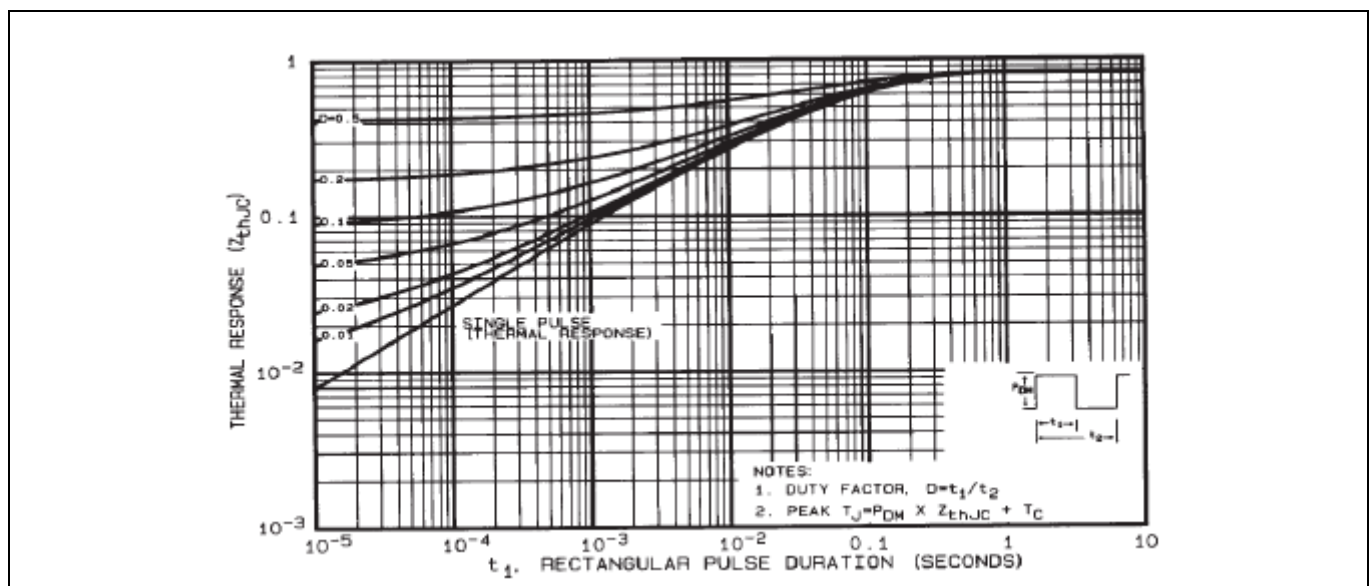


Figure 12 Maximum Effective Transient Thermal Impedance, Junction-to-Case

IRH7250

Radiation Hardened Power MOSFET Thru-Hole (TO-204AE)

Test Circuits (Pre-irradiation)

4 Test Circuits (Pre-irradiation)

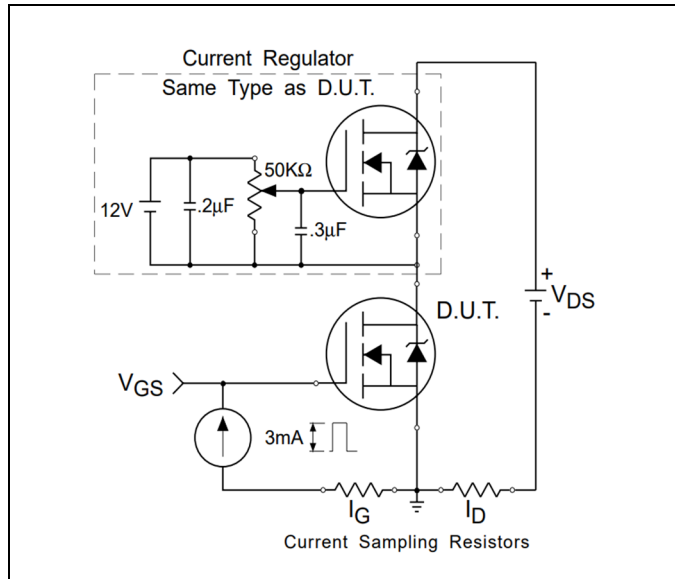


Figure 13 Gate Charge Test Circuit

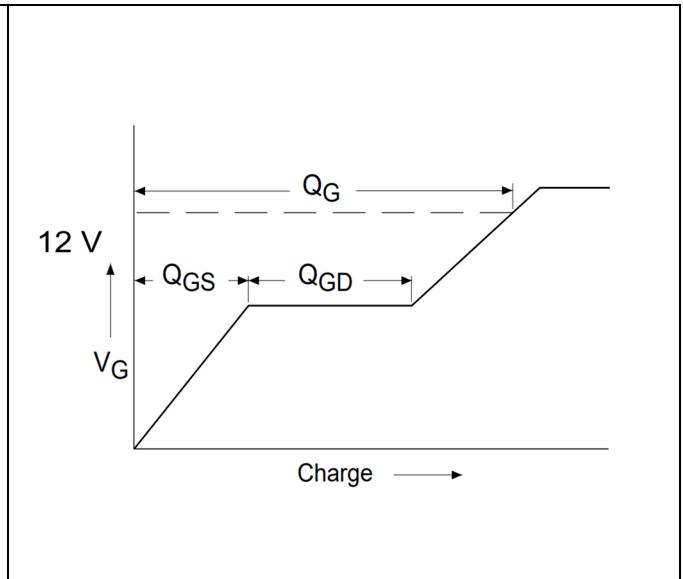


Figure 14 Gate Charge Waveform

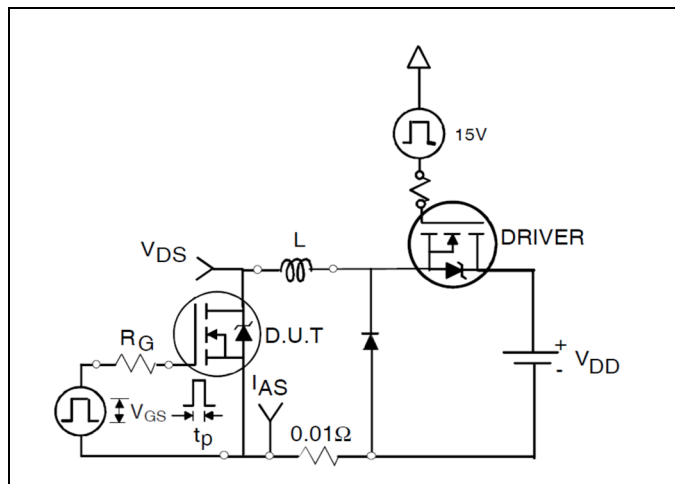


Figure 15 Unclamped Inductive Test Circuit

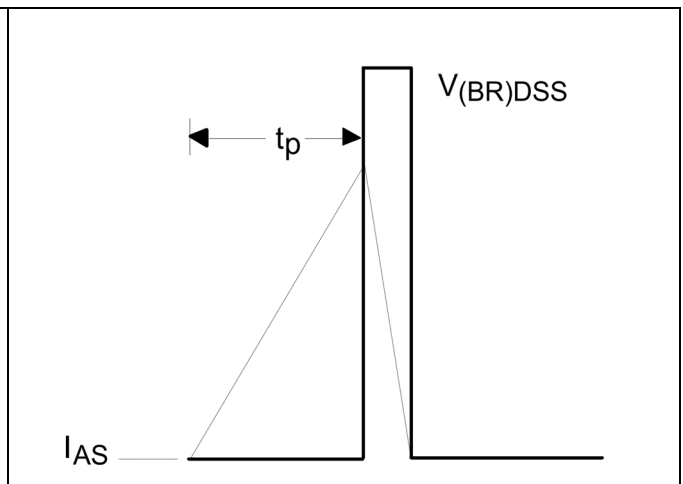


Figure 16 Unclamped Inductive Waveform

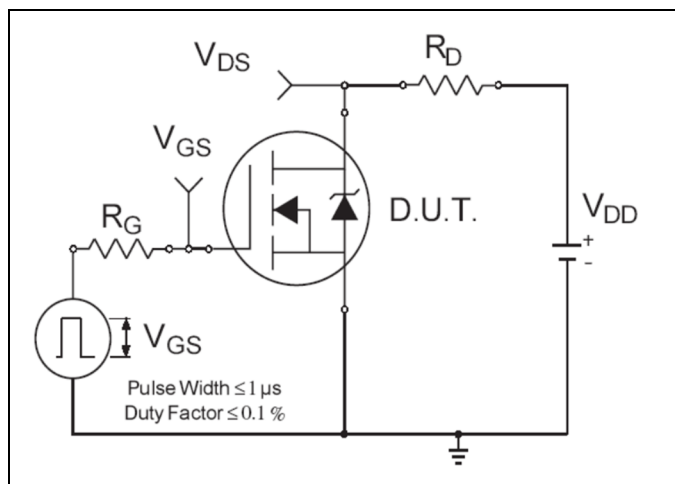


Figure 17 Switching Time Test Circuit

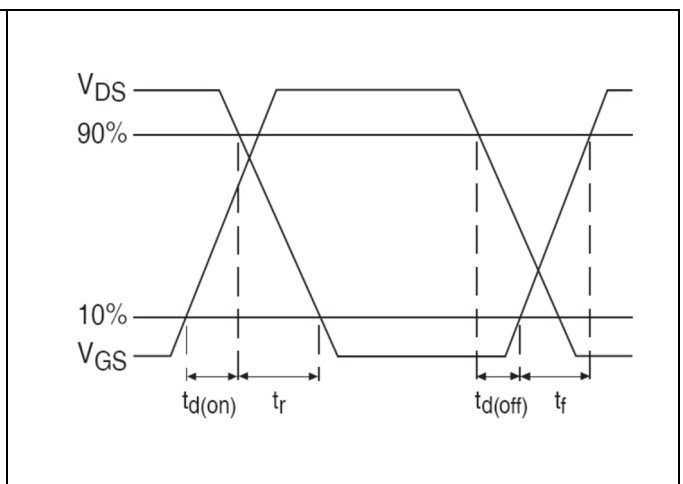
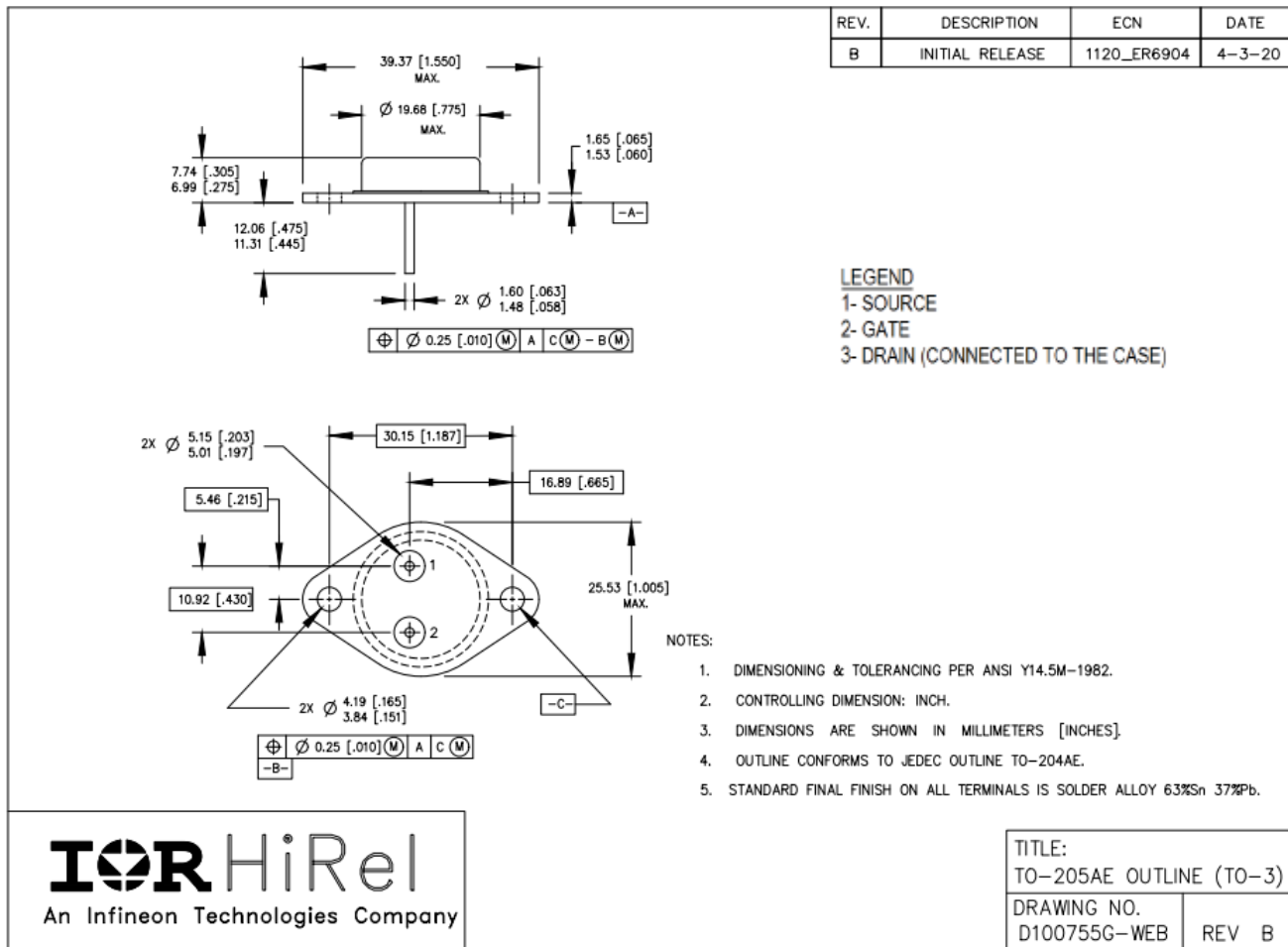


Figure 18 Switching Time Waveforms

Package Outline

5 Package Outline

Note: For the most updated package outline, please see the website: [TO-204AE](#)



Revision history

Revision history

Document version	Date of release	Description of changes
	09/14/1998	Datasheet (PD-90697A)
Rev B	10/14/1998	Updated Title-MEGA RAD HARD
Rev C	10/28/1998	Updated RTHCS
Rev D	06/05/2001	Updated switch time test condition
Rev E	12/04/2002	Updated Gate charge
Rev F	07/29/2019	Updated based on ECN-1120_06844-3
Rev G	05/16/2022	Updated based on ECN-1120_09018

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