IRHMS67264 (JANSR2N7586T1)

PD-96991D

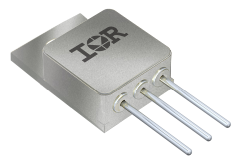
Radiation Hardened Power MOSFET
Thru-Hole (TO-254AA Low Ohmic)
250V, 45A, N-channel, R6 Technology

Features

- Single event effect (SEE) hardened (up to LET of 85 MeV·cm²/mg)
- Low $R_{DS(on)}$
- Fast switching
- Low total gate charge
- Simple drive requirements
- Hermetically sealed
- Electrically isolated
- Ceramic eyelets
- Light weight
- ESD rating: Class 3A per MIL-STD-750, Method 1020

Product Summary

- **Part number:** IRHMS67264 (JANSR2N7586T1), IRHMS63264 (JANSR2N7586T1)
- **REF:** MIL-PRF-19500/753
- **Radiation level:** 100 krad (Si), 300 krad (Si)
- **$R_{DS(on), max}$:** 41mΩ



TO-254AA Low Ohmic

Potential Applications

- DC-DC converter
- Motor drives

Product Validation

Qualified to JANS screening flow according to MIL-PRF-19500 for space applications

Description

IR HiRel R6 technology provides superior power MOSFETs for space applications. These devices have improved immunity to Single Event Effect (SEE) and have been characterized for useful performance with Linear Energy Transfer (LET) up to 85 MeV·cm²/mg. Their combination of low $R_{DS(on)}$ and fast switching times will allow for better performance in applications such as DC-DC converters or motor drives. 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
IRHMS67264	Low-Ohmic TO-254AA	COTS	100 krad (Si)
IRHMS67264SCS	Low-Ohmic TO-254AA	S-Level	100 krad (Si)
JANSR2N7586T1	Low-Ohmic TO-254AA	JANS	100 krad (Si)
IRHMS63264	Low-Ohmic TO-254AA	COTS	300 krad (Si)
IRHMS63264SCS	Low-Ohmic TO-254AA	S-Level	300 krad (Si)
JANSF2N7586T1	Low-Ohmic TO-254AA	JANS	300 krad (Si)

Please read the Important Notice and Warnings at the end of this document

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1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings (Pre-Irradiation)

Symbol	Parameter	Value	Unit
I_{D1} @ V_{GS} = 12V, T_C = 25°C	Continuous Drain Current	45*	A
I_{D2} @ V_{GS} = 12V, T_C = 100°C	Continuous Drain Current	28.5	A
I_{DM} @ T_C = 25°C	Pulsed Drain Current [1]	180	A
P_D @ T_C = 25°C	Maximum Power Dissipation	208	W
	Linear Derating Factor	1.67	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy [2]	251	mJ
I_{AR}	Avalanche Current [1]	45	A
E_{AR}	Repetitive Avalanche Energy [1]	20.8	mJ
dv/dt	Peak Diode Reverse Recovery [3]	4.4	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	9.3 (Typical)	g

*Current is limited by package

[1] Repetitive Rating; Pulse width limited by maximum junction temperature.
[2] V_{DD} = 50V, starting T_J = 25°C, L = 0.25mH, Peak I_L = 45A, V_{GS} = 12V
[3] $I_{SD} \leq$ 45A, di/dt $\leq$ 1470A/µs, $V_{DD} \leq$ 250V, $T_J \leq$ 150°C

2 Device Characteristics

2.1 Electrical Characteristics (Pre-Irradiation)

Table 3 Static and Dynamic Electrical Characteristics @ T_j = 25°C (Unless Otherwise Specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	—	—	V	V_{GS} = 0V, I_D = 1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.31	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	41	mΩ	V_{GS} = 12V, I_{D2} = 28.5A [1]
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	V_{DS} = V_{GS}, I_D = 1mA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	—	-10.89	—	mV/°C	
Gfs	Forward Transconductance	37	—	—	S	V_{DS} = 15V, I_{D2} = 28.5A [1]
I_{DSS}	Zero Gate Voltage Drain Current	—	—	10	µA	V_{DS} = 200V, V_{GS} = 0V
		—	—	25		V_{DS} = 200V, 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	—	—	220	nC	I_{D1} = 45A V_{DS} = 125V V_{GS} = 12V
Q_{GS}	Gate-to-Source Charge	—	—	50		
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	70		
$t_{d(on)}$	Turn-On Delay Time	—	—	40	ns	I_{D1} = 45A ** V_{DD} = 125V R_G = 2.35Ω V_{GS} = 12V
t_r	Rise Time	—	—	125		
$t_{d(off)}$	Turn-Off Delay Time	—	—	85		
t_f	Fall Time	—	—	30		
$L_s + L_D$	Total Inductance	—	6.8	—	nH	Measured from Drain lead (6mm / 0.25in from package) to Source lead (6mm / 0.25in from package) with Source wire internally bonded from Source pin to Drain pad
C_{iss}	Input Capacitance	—	6847	—	pF	V_{GS} = 0V V_{DS} = 25V f = 1.0MHz
C_{oss}	Output Capacitance	—	933	—		
C_{rss}	Reverse Transfer Capacitance	—	12	—		
R_G	Gate Resistance	—	0.48	—	Ω	f = 1.0MHz, open drain

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

[1] Pulse width ≤ 300 µs; Duty Cycle ≤ 2%

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)	—	—	45	A	
I_{SM}	Pulsed Source Current (Body Diode) [1]	—	—	180	A	
V_{SD}	Diode Forward Voltage	—	—	1.2	V	$T_J = 25°C$, $I_S = 45A$, $V_{GS} = 0V$ [2]
t_{rr}	Reverse Recovery Time	—	—	700	ns	$T_J = 25°C$, $I_F = 45A$, $V_{DD} \leq 50V$ di/dt = 100A/µs [2]
Q_{rr}	Reverse Recovery Charge	—	—	14.3	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	—	—	0.6	°C/W
$R_{\theta CS}$	Junction-to-Sink	—	0.21	—	
$R_{\theta JA}$	Junction-to-Ambient (Typical socket mount)	—	—	48	

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 @ $T_J = 25°C$, Post Total Dose Irradiation [3, 4]

Symbol	Parameter	Up to 300 krad (Si)[5]		Unit	Test Conditions
		Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	—	V	$V_{GS} = 0V$, $I_D = 1.0mA$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	V	$V_{DS} = V_{GS}$, $I_D = 1.0mA$
I_{GSS}	Gate-to-Source Leakage Forward	—	100	nA	$V_{GS} = 20V$
	Gate-to-Source Leakage Reverse	—	-100		$V_{GS} = -20V$
I_{DSS}	Zero Gate Voltage Drain Current	—	10	µA	$V_{DS} = 200V$, $V_{GS} = 0V$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3) [2]	—	41	mΩ	$V_{GS} = 12V$, $I_{D2} = 28.5A$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-254AA) [2]	—	41	mΩ	$V_{GS} = 12V$, $I_{D2} = 28.5A$
V_{SD}	Diode Forward Voltage	—	1.2	V	$V_{GS} = 0V$, $I_F = 45A$

[1] Repetitive Rating; Pulse width limited by maximum junction temperature.
[2] Pulse width ≤ 300 µs; Duty Cycle ≤ 2%
[3] Total Dose Irradiation with V_{GS} Bias. $V_{GS} = 12V$ applied and $V_{DS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.
[4] Total Dose Irradiation with V_{DS} Bias. $V_{DS} = 200V$ applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.
[5] Part numbers IRHMS67264 (JANSR2N7586T1) and IRHMS63264 (JANSR2F7586T1)

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

LET ($MeV \cdot cm^2/mg$)	Energy (MeV)	Range (µm)	V_{DS} (V)				
			V_{GS} = 0V	V_{GS} = -5V	V_{GS} = -10V	V_{GS} = -15V	V_{GS} = -20V
50 ± 5%	821 ± 5%	74.2 ± 5%	250	250	250	250	40
59 ± 5%	1040 ± 5%	79.7 ± 5%	225	225	225	50	—
85 ± 5%	1908 ± 5%	101.2 ± 5%	75	75	—	—	—

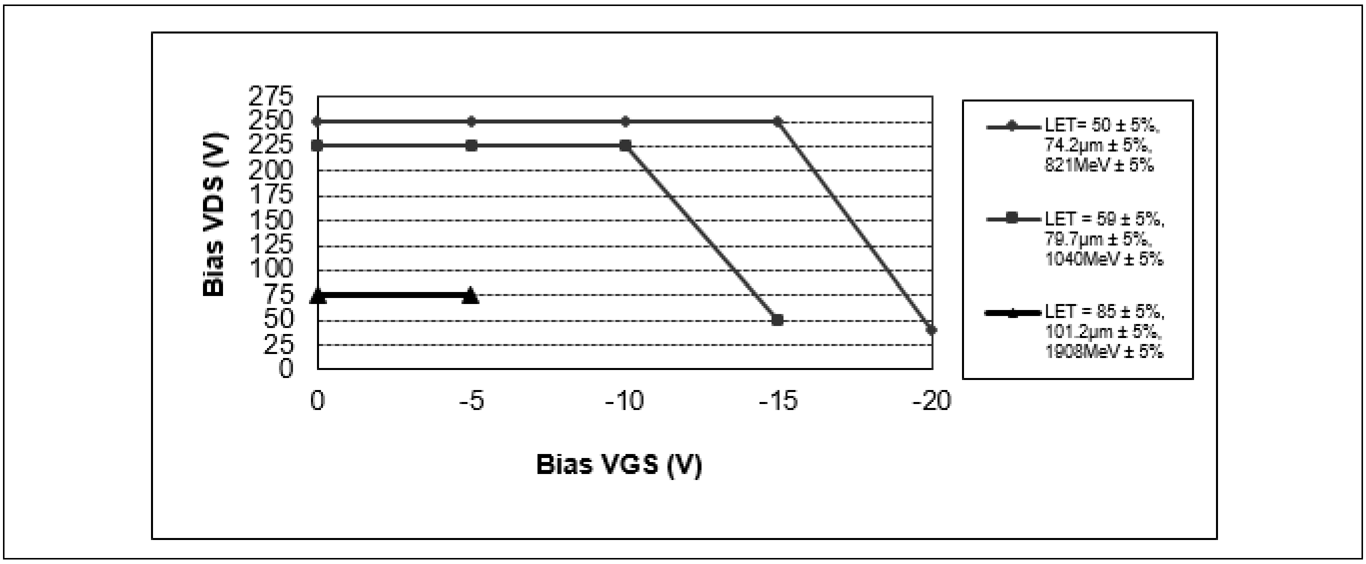


Figure 1 Typical Single Event Effect, Safe Operating Area

3 Electrical Characteristics Curves (Pre-irradiation)

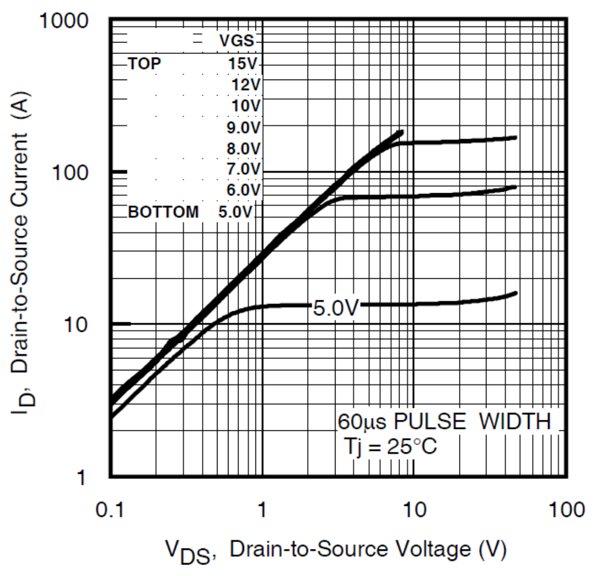


Figure 2 Typical Output Characteristics

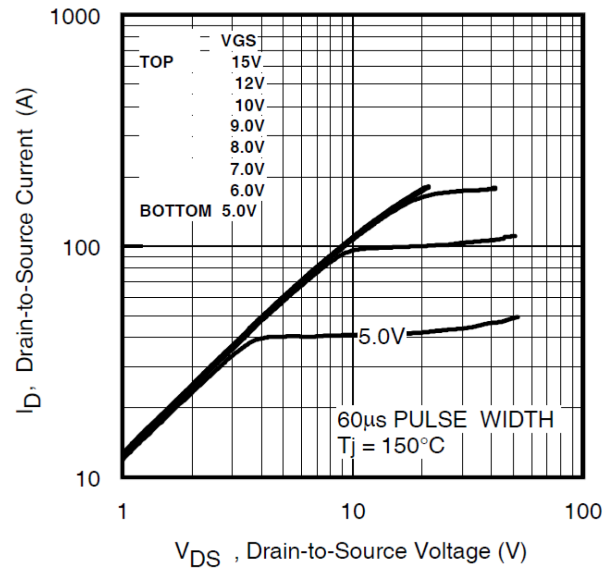


Figure 3 Typical Output Characteristics

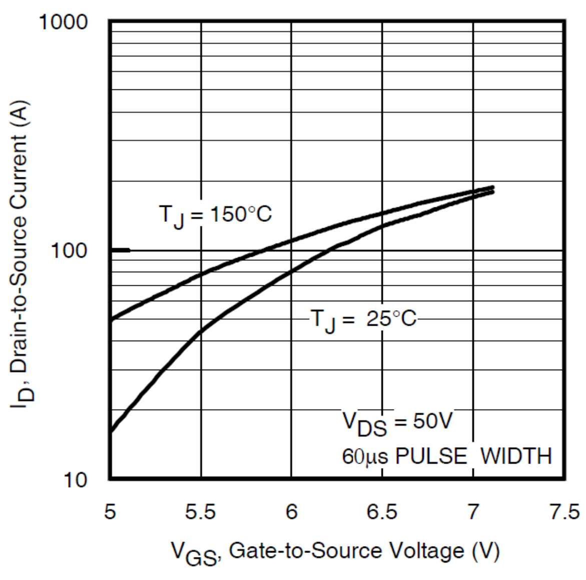


Figure 4 Typical Transfer Characteristics

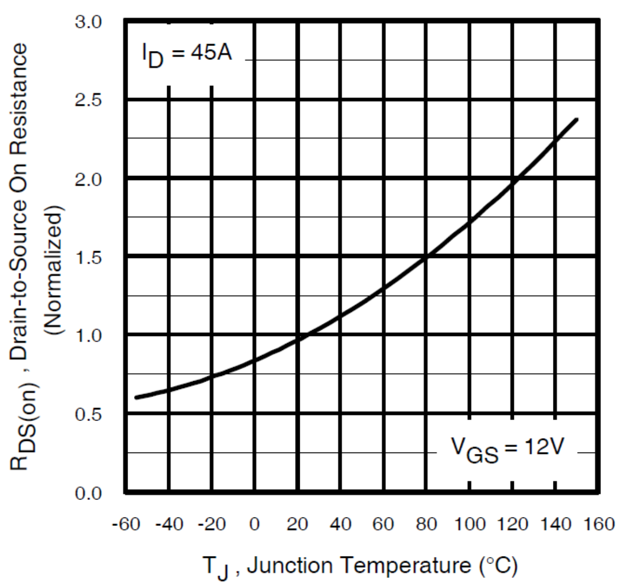


Figure 5 Normalized On-Resistance Vs. Temperature

Electrical Characteristics Curves (Pre-irradiation)

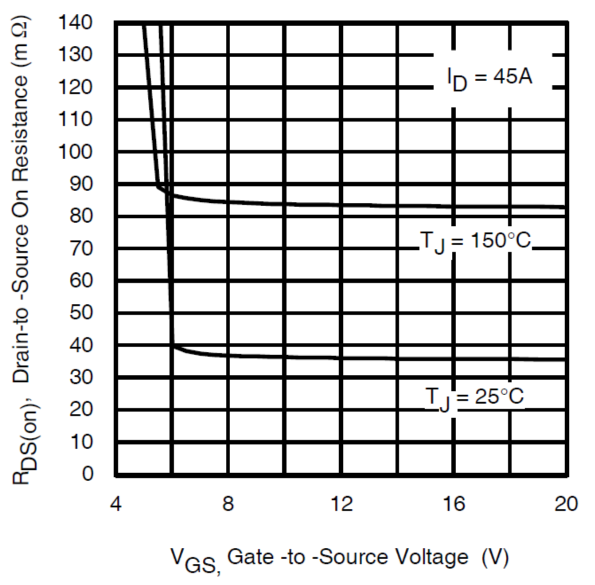


Figure 6 **Typical On-Resistance Vs Gate Voltage**

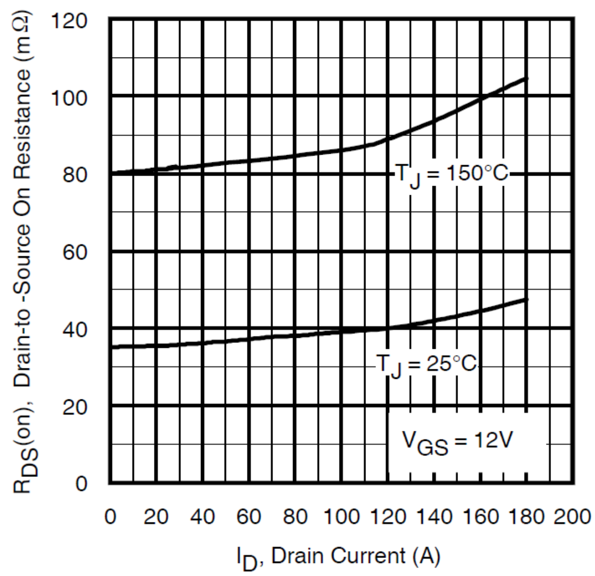


Figure 7 **Typical On-Resistance Vs Drain Current**

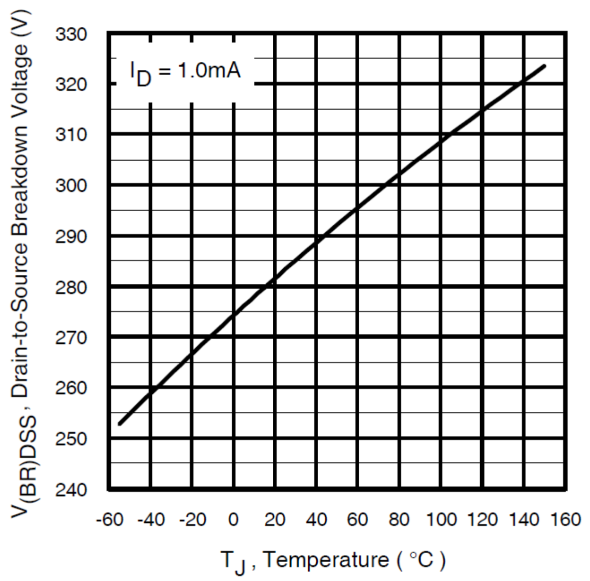


Figure 8 **Typical Drain-to-Source Breakdown Voltage Vs. Temperature**

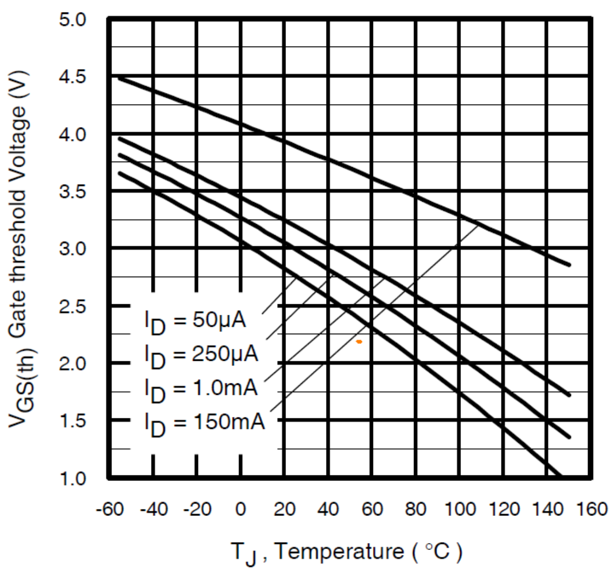


Figure 9 **Typical Gate-to-Source Voltage Vs. Temperature**

Electrical Characteristics Curves (Pre-irradiation)

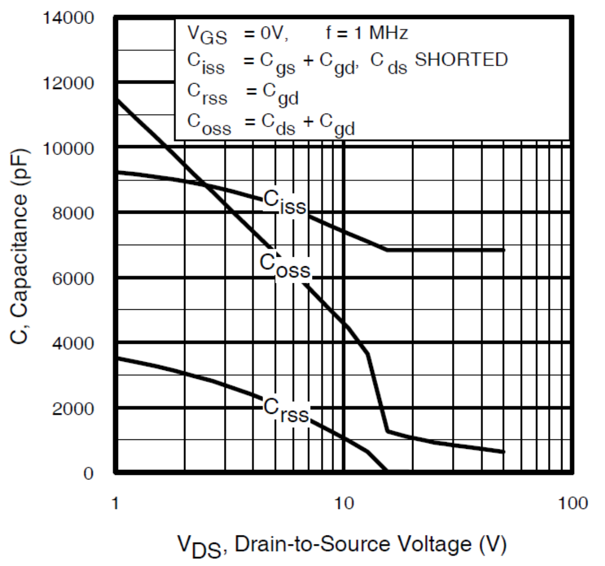


Figure 10 **Typical Capacitance Vs. Drain-to-Source Voltage**

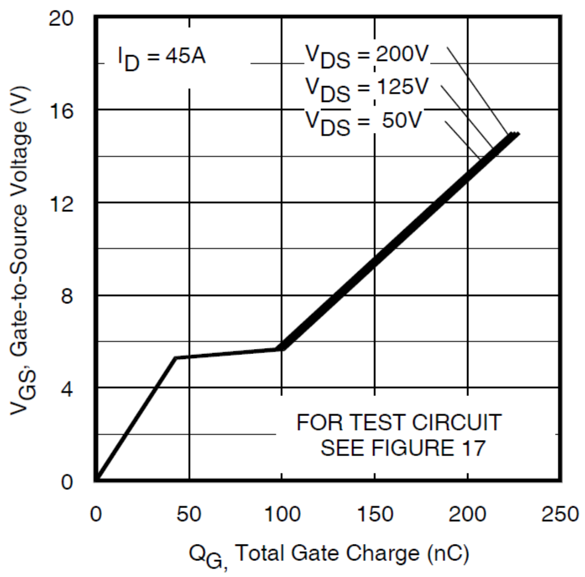


Figure 11 **Gate-to-Source Voltage Vs. Typical Gate Charge**

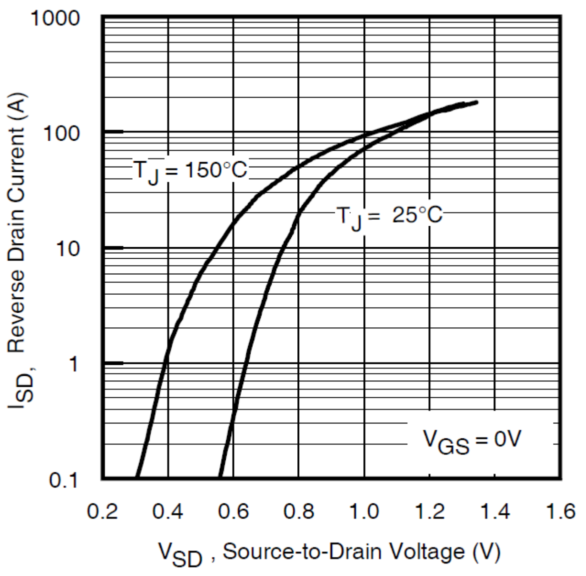


Figure 12 **Typical Source-Drain Current Vs. Diode Forward Voltage**

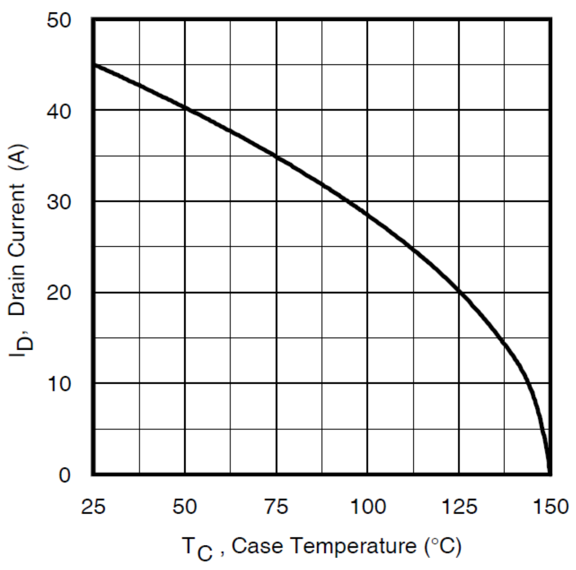


Figure 13 **Maximum Drain Current Vs. Temperature**

Electrical Characteristics Curves (Pre-irradiation)

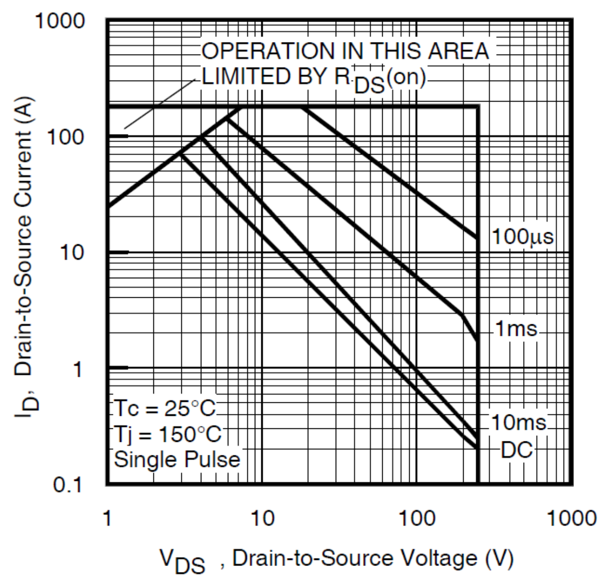


Figure 14 Maximum Safe Operating Area

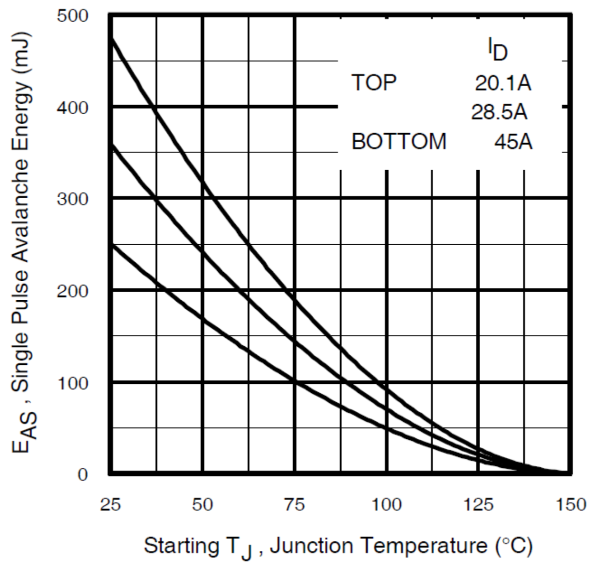


Figure 15 Maximum Avalanche Energy Vs. Junction Temperature

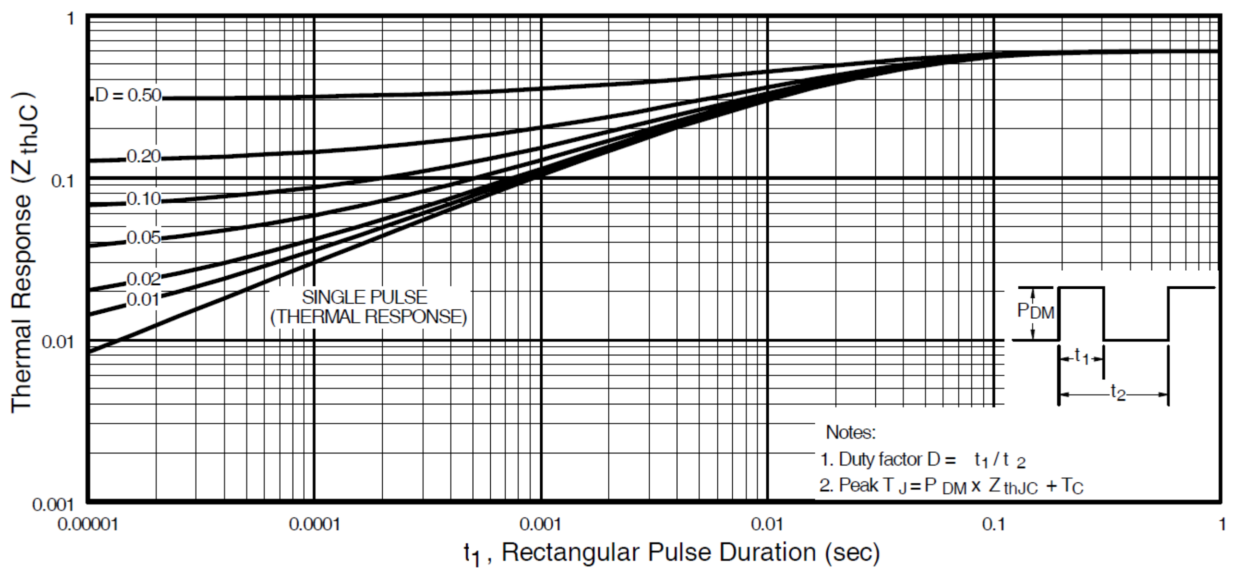


Figure 16 Maximum Effective Transient Thermal Impedance, Junction-to-Case

4 Test Circuits (Pre-irradiation)

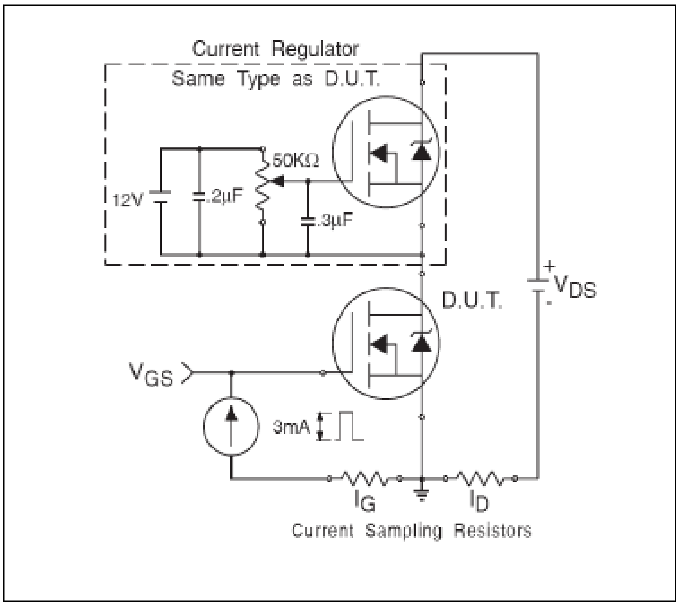


Figure 17 **Gate Charge Test Circuit**

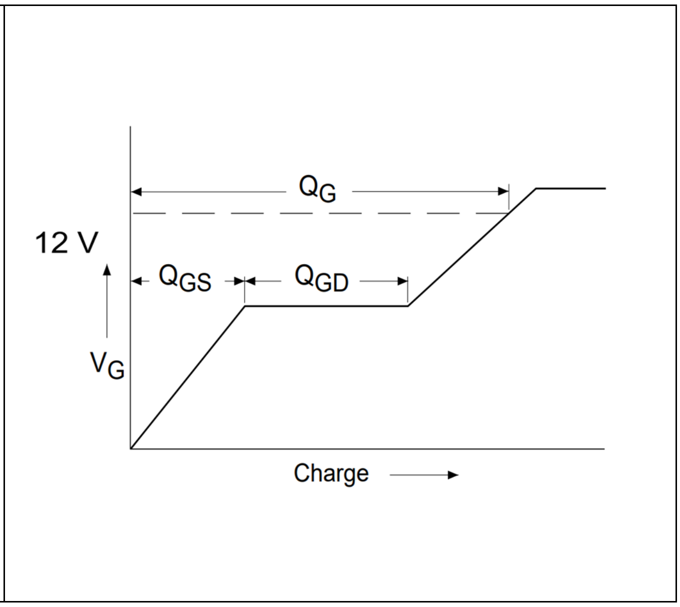


Figure 18 **Gate Charge Waveform**

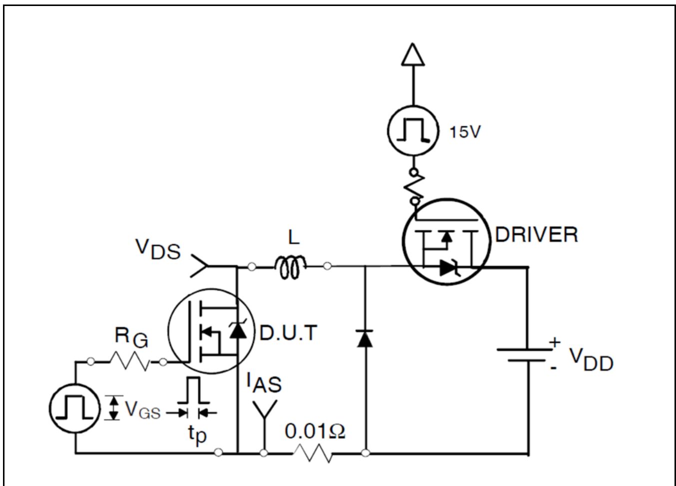


Figure 19 **Unclamped Inductive Test Circuit**

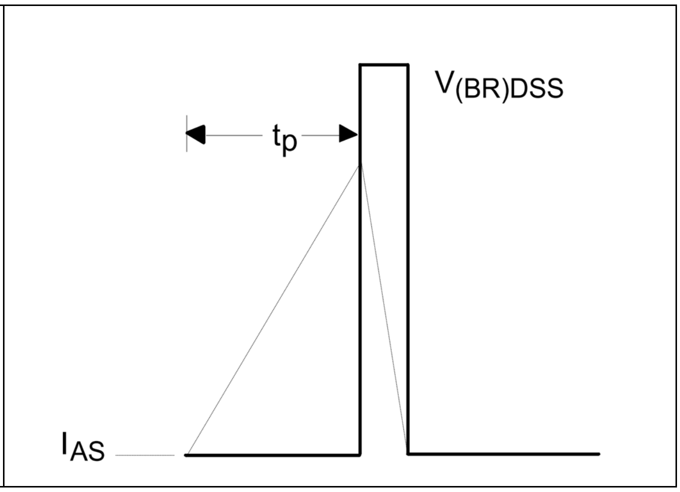


Figure 20 **Unclamped Inductive Waveform**

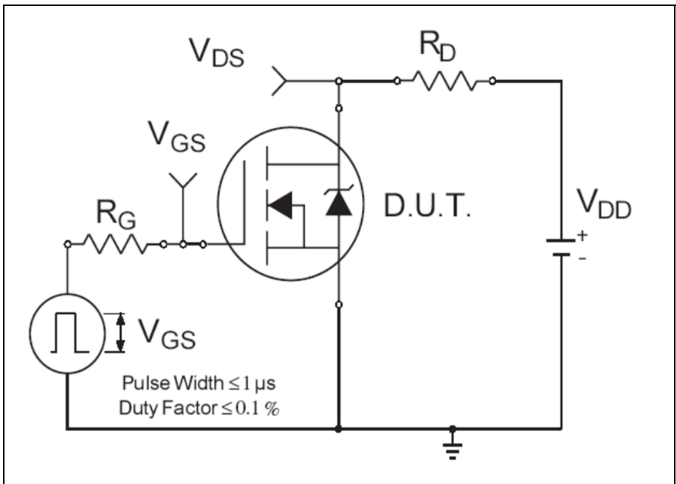


Figure 21 **Switching Time Test Circuit**

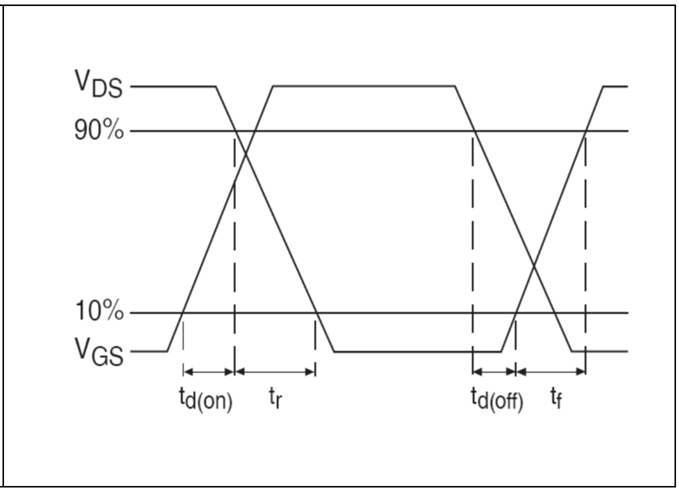
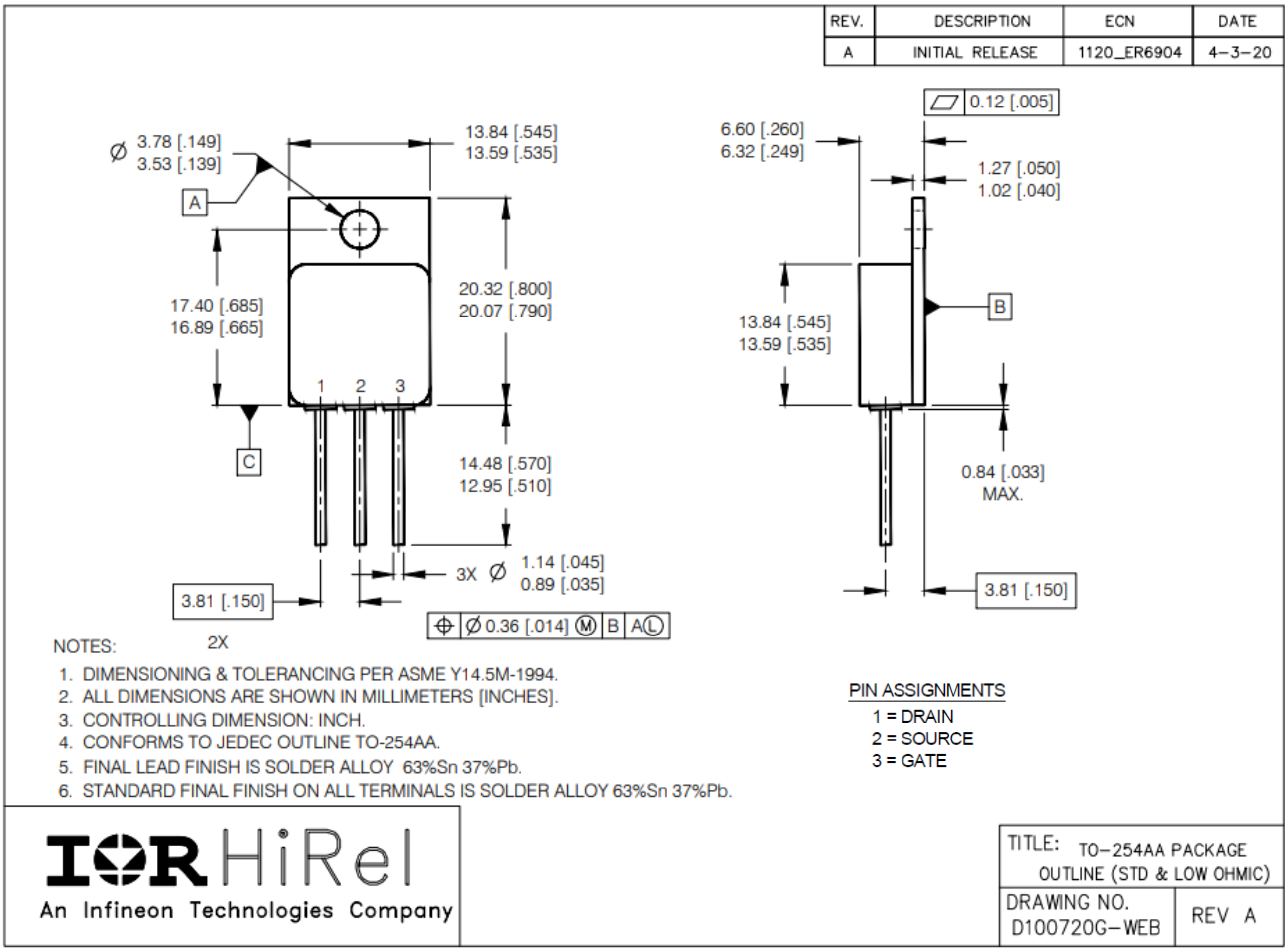


Figure 22 **Switching Time Waveforms**

5 Package Outline

Note: For the most updated package outline, please see the website: [TO-254AA]



BERYLLIA WARNING PER MIL-PRF-19500

Package containing beryllia shall not be ground, sandblasted, machined, or have other operations performed on them which will produce beryllia or beryllium dust. Furthermore, beryllium oxide packages shall not be placed in acids that will produce fumes containing beryllium.

Revision history

Document version	Date of release	Description of changes
	6/28/2005	Final datasheet with PD number (PD-96991)
Rev A	12/22/2011	Updated based on ECN-18135
Rev B	03/28/2014	Updated based on ECN-1120_01961
Rev C	11/12/2020	Updated based on ECN-1120_08235
Rev D	03/07/2022	Updated based on ECN-1120_08906

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