IRHMS57Z60 (JANSR2N7478T1)

PD-96961D

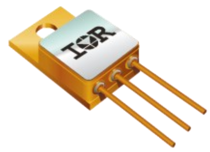
Radiation Hardened Power MOSFET
Thru-Hole (Low-Ohmic TO-254AA)
30V, 45A, N-channel, R5 Technology

Features

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

Product Summary

- **BV_{DSS}:** 30V
- **I_D :** 45A
- **$R_{DS(on),max}$:** 5.5mΩ
- **$Q_{G,max}$:** 240nC
- **REF:** MIL-PRF-19500/697



Low-Ohmic TO-254AA

Potential Applications

- Synchronous rectification
- Point-of-load converter
- Motor drives

Product Validation

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

Description

IR HiRel R5 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
IRHMS57Z60	Low-Ohmic TO-254AA	COTS	100 krad(Si)
IRHMS57Z60SCS	Low-Ohmic TO-254AA	S-Level	100 krad(Si)
JANSR2N7478T1	Low-Ohmic TO-254AA	JANS	100 krad(Si)
IRHMS53Z60	Low-Ohmic TO-254AA	COTS	300 krad(Si)
IRHMS53Z60SCS	Low-Ohmic TO-254AA	S-Level	300 krad(Si)
JANSF2N7478T1	Low-Ohmic TO-254AA	JANS	300 krad(Si)
IRHMS54Z60	Low-Ohmic TO-254AA	COTS	500 krad(Si)
JANSG2N7478T1	Low-Ohmic TO-254AA	JANS	500 krad(Si)

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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	45*	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]	1250	mJ
I_{AR}	Avalanche Current [1]	45	A
E_{AR}	Repetitive Avalanche Energy [1]	20.8	mJ
dv/dt	Peak Diode Reverse Recovery [3]	1.08	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)	°C
	Weight	9.3 (Typical)	g

* Current is limited by package

[1] Repetitive Rating; Pulse width limited by maximum junction temperature.
[2] V_{DD} = 25V, starting T_J = 25°C, L = 1.1mH, Peak I_L = 45A, V_{GS} = 12V
[3] $I_{SD} \leq 45A$, di/dt ≤ 150A/µs, $V_{DD} \leq 30V$, $T_J \leq 150°C$

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	30	—	—	V	V_{GS} = 0V, I_D = 1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.03	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	5.5	mΩ	V_{GS} = 12V, I_{D2} = 45A [1]
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}$, I_D = 1mA
Gfs	Forward Transconductance	73	—	—	S	V_{DS} = 15V, I_{D2} = 45A [1]
I_{DSS}	Zero Gate Voltage Drain Current	—	—	10	µA	V_{DS} = 24V, V_{GS} = 0V
		—	—	25		V_{DS} = 24V, 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	—	—	240	nC	I_{D1} = 45A V_{DS} = 15V V_{GS} = 12V
Q_{GS}	Gate-to-Source Charge	—	—	60		
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	55		
$t_{d(on)}$	Turn-On Delay Time	—	—	35	ns	I_{D1} = 45A ** V_{DD} = 15V R_G = 2.35Ω V_{GS} = 12V
t_r	Rise Time	—	—	175		
$t_{d(off)}$	Turn-Off Delay Time	—	—	80		
t_f	Fall Time	—	—	40		
$L_s + L_D$	Total Inductance	—	6.8	—	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 pad
C_{iss}	Input Capacitance	—	8884	—	pF	V_{GS} = 0V V_{DS} = 25V f = 1.0MHz
C_{oss}	Output Capacitance	—	4334	—		
C_{rss}	Reverse Transfer Capacitance	—	270	—		
R_G	Gate Resistance	—	0.73	—	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	—	—	140	ns	T_J = 25°C, I_F = 45A, $V_{DD} \leq$ 25V di/dt = 100A/µs [2]
Q_{rr}	Reverse Recovery Charge	—	318	—	nC	
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	—	—	0.60	°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 500 krad (Si) [5]		Unit	Test Conditions
		Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	30	—	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} = 24V, V_{GS} = 0V
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3) [2]	—	4.0	mΩ	V_{GS} = 12V, I_{D2} = 45A
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-254AA) [2]	—	5.5	mΩ	V_{GS} = 12V, I_{D2} = 45A
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} = 24V applied and V_{GS} = 0 during irradiation per MIL-STD-750, Method 1019, condition A.

[5] Part numbers IRHMS57Z60 (JANSR2N7478T1), IRHM53Z60 (JANSF2N7478T1) and IRHMS54Z60 (JANSG2N7478T1)

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·cm²/mg)	Energy (MeV)	Range (µm)	V_{DS} (V)				
			V_{GS} = 0V	V_{GS} = -5V	V_{GS} = -10V	V_{GS} = -15V	V_{GS} = -20V
38 ± 5%	300 ± 7.5%	38 ± 7.5%	30	30	30	22.5	15
61 ± 5%	330 ± 7.5%	31 ± 10%	25	25	20	15	7.5
84 ± 5%	350 ± 10%	28 ± 7.5%	25	25	20	—	—

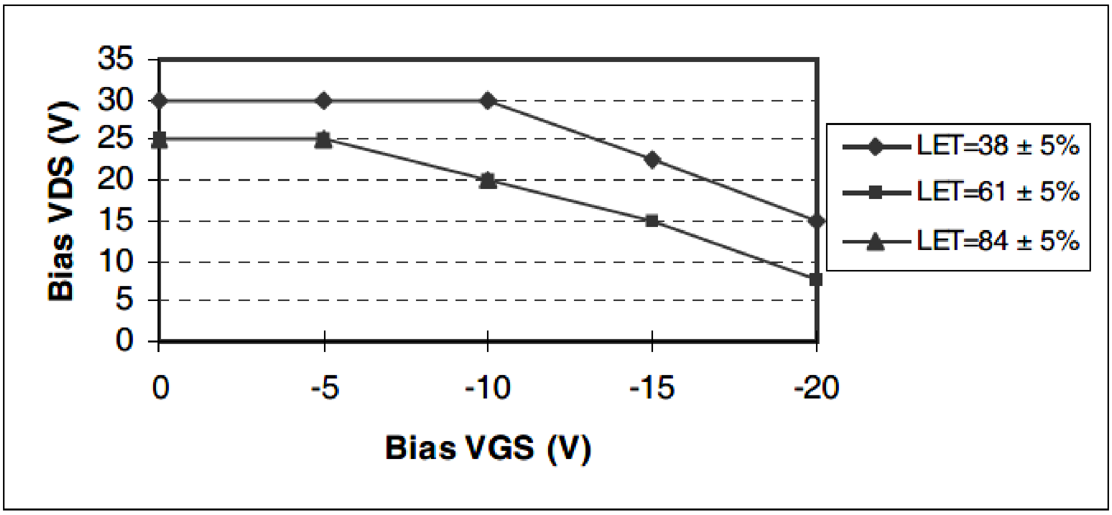


Figure 1 Typical Single Event Effect, Safe Operating Area

3 Electrical Characteristics Curves (Pre-irradiation)

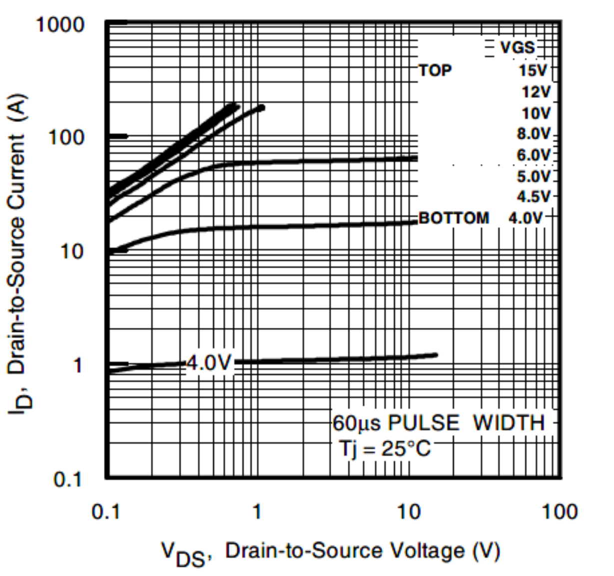


Figure 2 **Typical Output Characteristics**

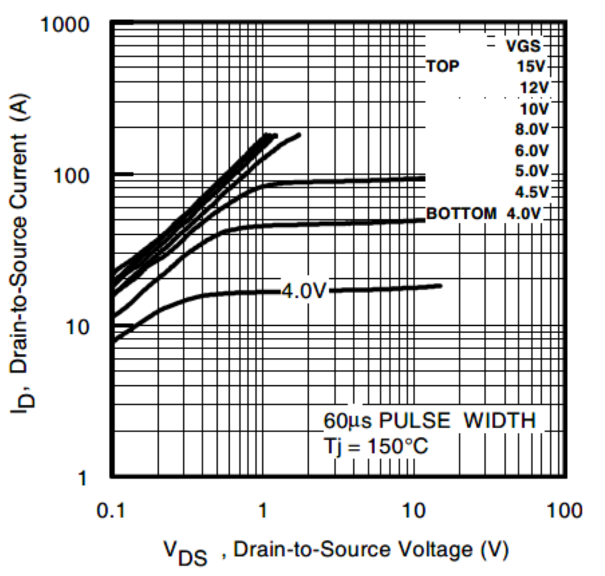


Figure 3 **Typical Output Characteristics**

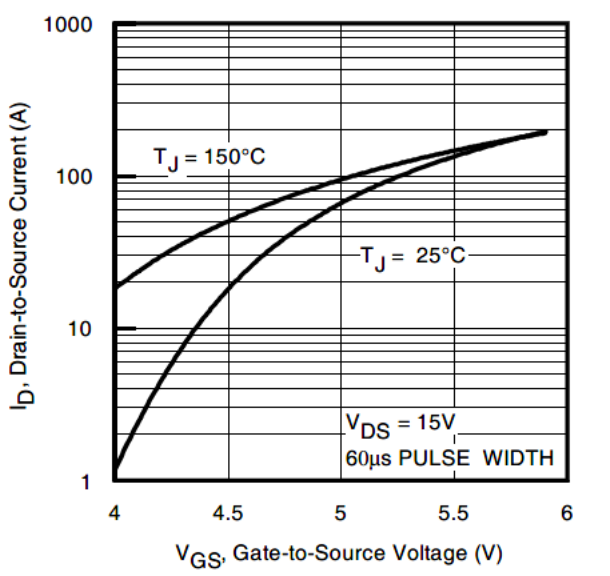


Figure 4 **Typical Transfer Characteristics**

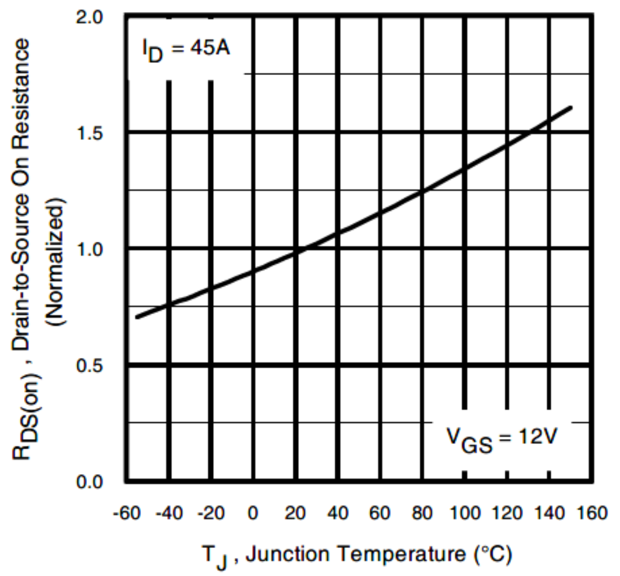


Figure 5 **Normalized On-Resistance Vs. Temperature**

Electrical Characteristics Curves (Pre-irradiation)

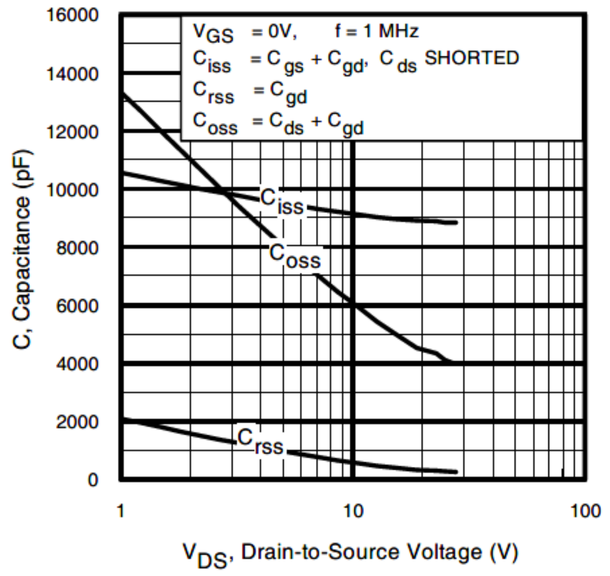


Figure 6 **Typical Capacitance Vs. Drain-to-Source Voltage**

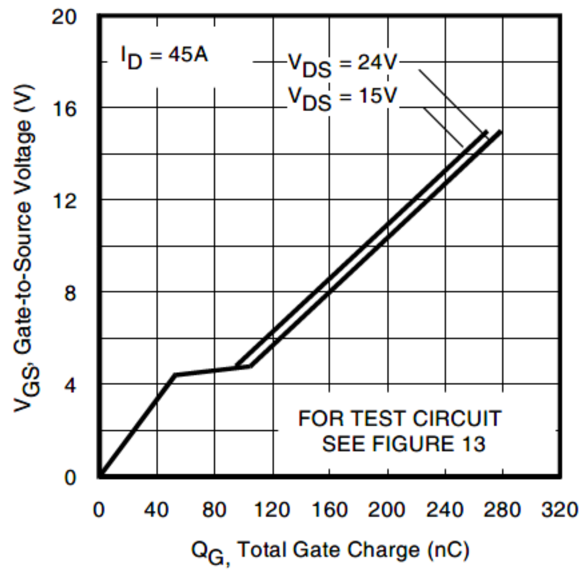


Figure 7 **Typical Gate Charge Vs. Gate-to-Source Voltage**

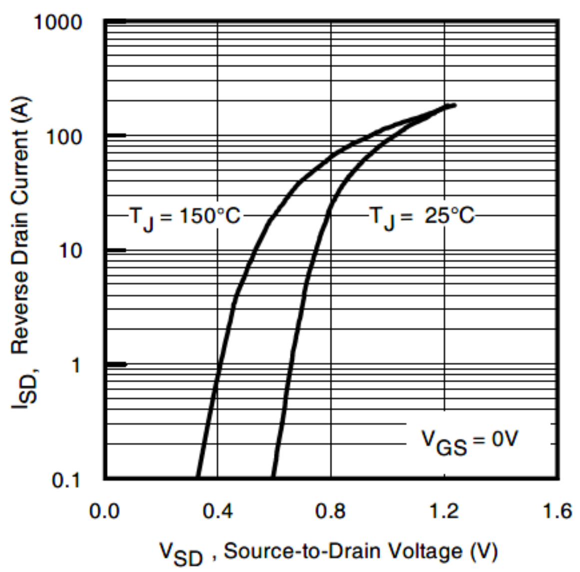


Figure 8 **Typical Source-Drain Current Vs. Diode Forward Voltage**

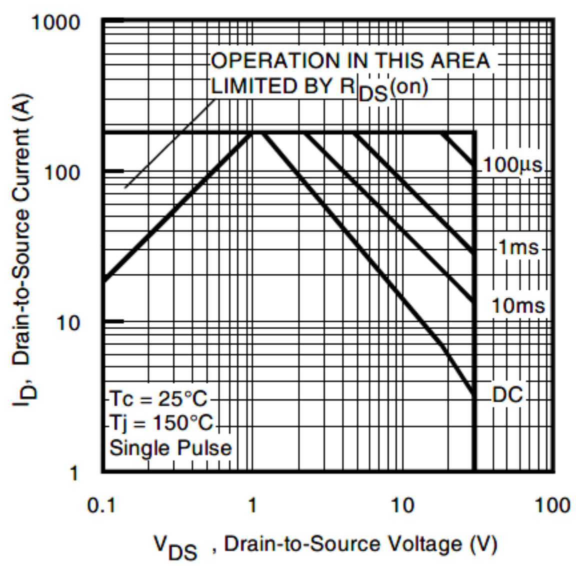


Figure 9 **Maximum Safe Operating Area**

Electrical Characteristics Curves (Pre-irradiation)

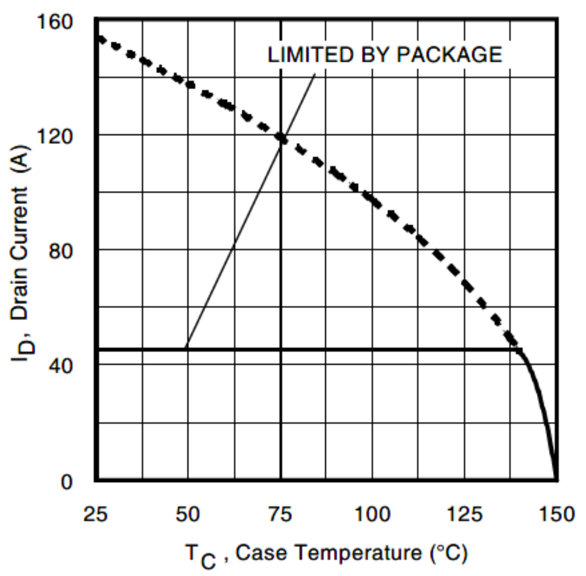


Figure 10 Maximum Drain Current Vs. Case Temperature

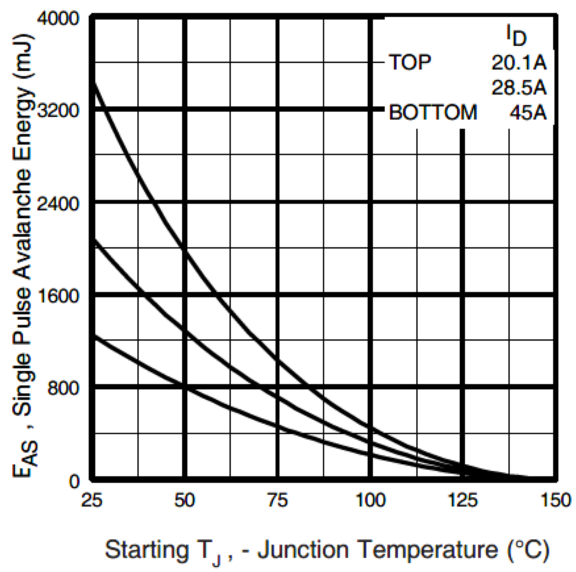


Figure 11 Maximum Avalanche Energy Vs. Junction Temperature

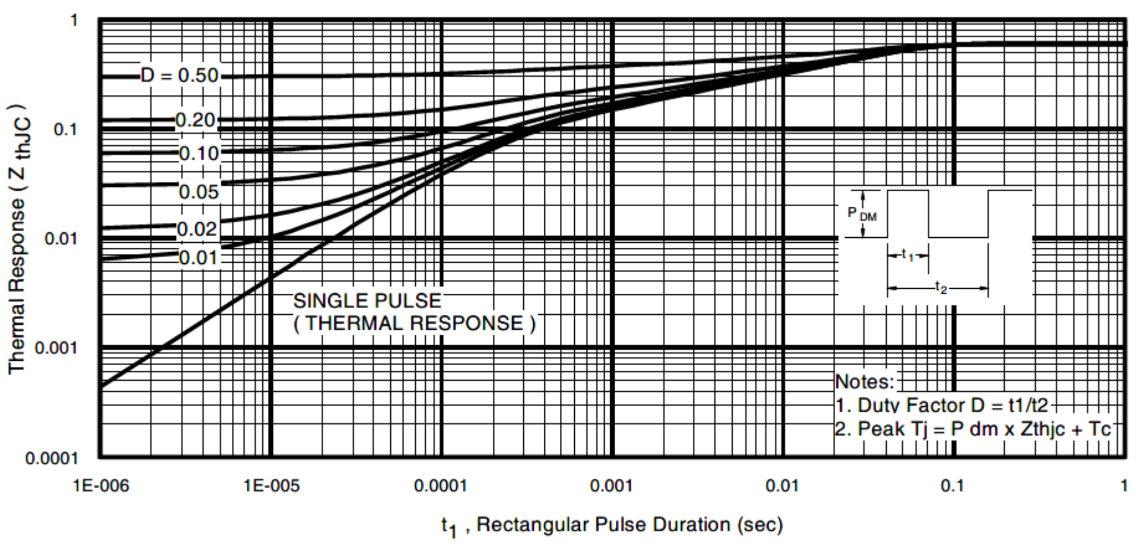


Figure 12 Maximum Effective Transient Thermal Impedance, Junction-to-Case

4 Test Circuits (Pre-irradiation)

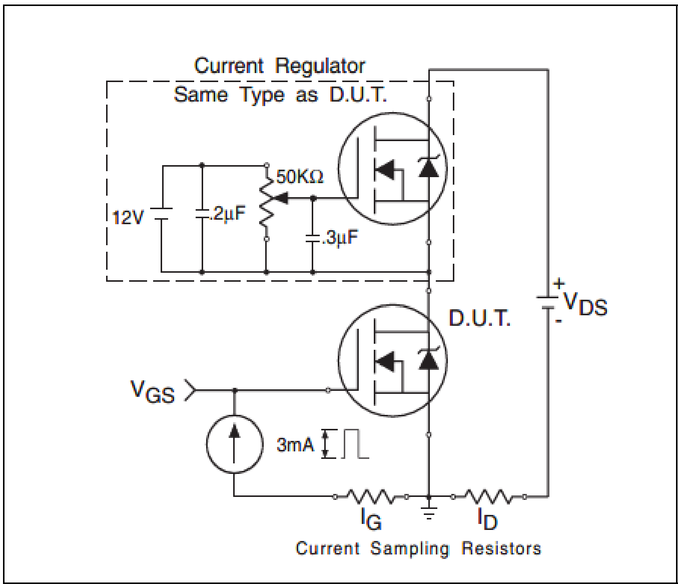


Figure 13 Gate Charge Test Circuit

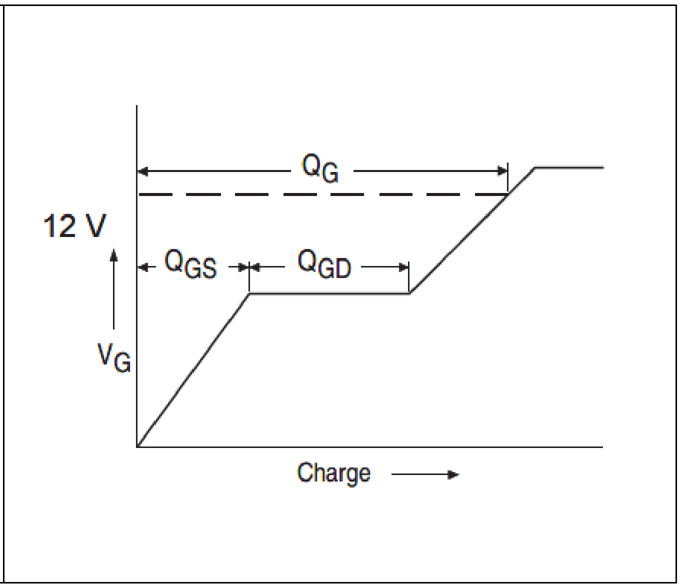


Figure 14 Gate Charge Waveform

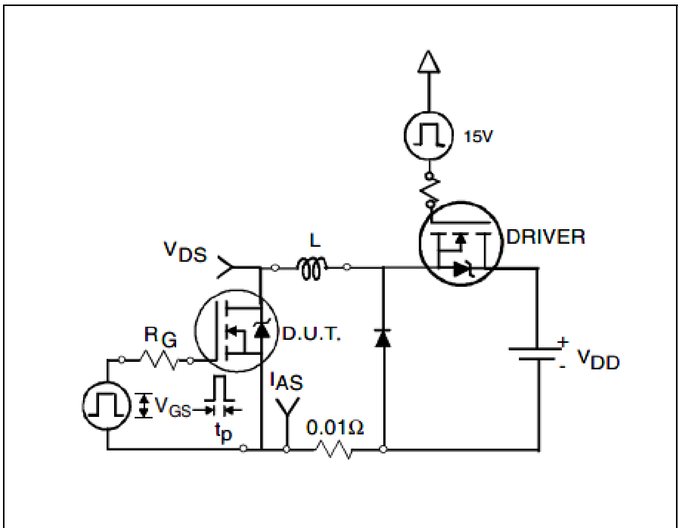


Figure 15 Unclamped Inductive Test Circuit

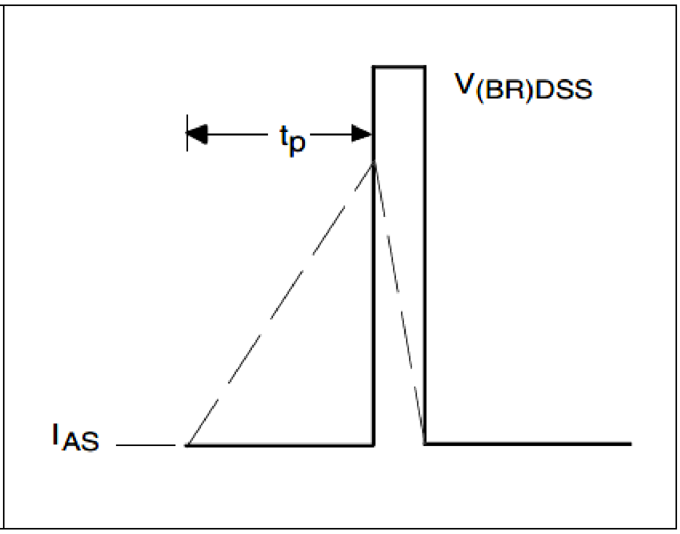


Figure 16 Unclamped Inductive Waveform

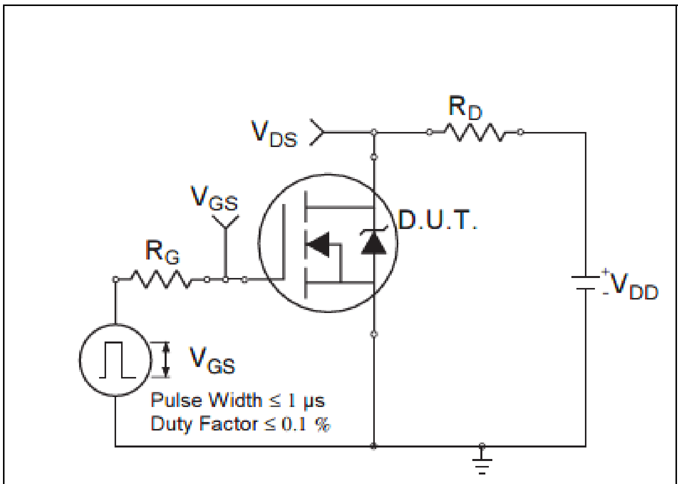


Figure 17 Switching Time Test Circuit

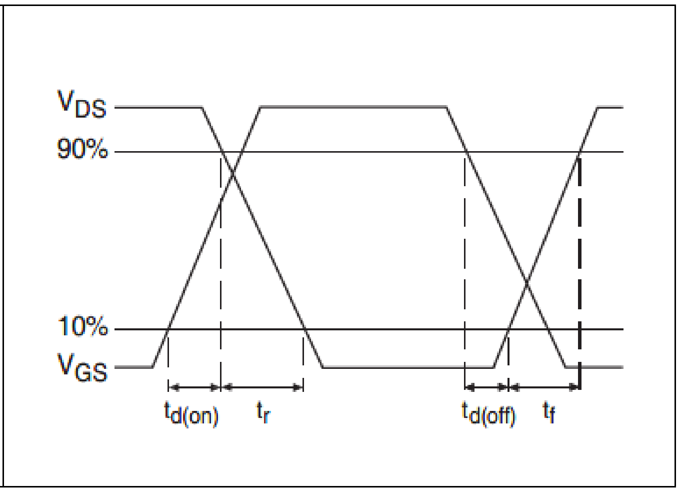
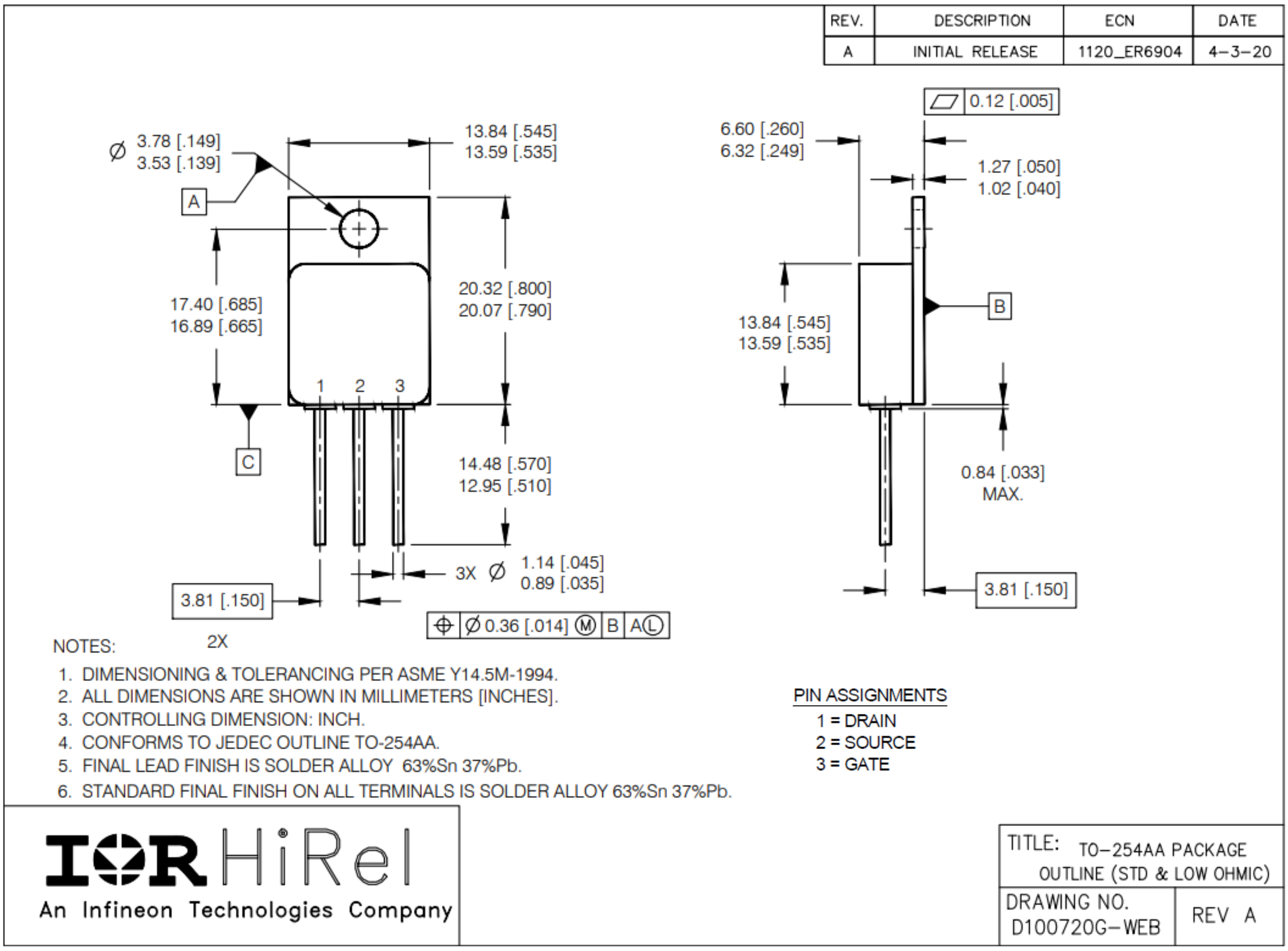


Figure 18 Switching Time Waveforms

5 Package Outline

Note: For the most updated package outline, please see the website: Low-Ohmic 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
	08/29/2005	Datasheet (PD-96961)
Rev A	04/25/2006	Updated 600kRad(si) to 500kRad(si)
Rev B	06/04/2018	Updated based on ECN-1120_03486
Rev C	05/26/2022	Updated based on ECN-1120_09018
Rev D	05/22/2025	Updated based on ECN-Z8F80794417

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