

**RADIATION HARDENED
POWER MOSFET
THRU-HOLE (Low-Ohmic TO-254AA)**
250V, N-CHANNEL
REF: MIL-PRF-19500/685

Product Summary

Part Number	Radiation Level	RDS(on)	I _D	QPL Part Number
IRHMS57264SE	100 kRads(Si)	0.061Ω	37A	JANSR2N7477T1


Description

IR HiRel R5 technology provides high performance power MOSFETs for space applications. These devices have been characterized for both Total Dose and Single Event Effect (SEE) with useful performance up to LET of 80 (MeV/(mg/cm²)). The combination of low RDS(on) and low gate charge reduces the power losses in switching applications such as DC-DC converters and motor controllers. These devices retain all of the well established advantages of MOSFETs such as voltage control, fast switching, ease of paralleling and temperature stability of electrical parameters.

Features

- Low RDS(on)
- Fast Switching
- Single Event Effect (SEE) Hardened
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Eyelets
- Electrically Isolated
- Light Weight
- ESD Rating: Class 3A per MIL-STD-750, Method 1020

Absolute Maximum Ratings
Pre-Irradiation

	Parameter		Units
I _D @ V _{GS} = 12V, T _C = 25°C	Continuous Drain Current	37	A
I _D @ V _{GS} = 12V, T _C = 100°C	Continuous Drain Current	23.5	
I _{DM}	Pulsed Drain Current ①	148	
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	258	mJ
I _{AR}	Avalanche Current ①	37	A
E _{AR}	Repetitive Avalanche Energy ①	20.8	mJ
dv/dt	Peak Diode Recovery dv/dt ③	14	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)	

For footnotes refer to the page 2.

Electrical Characteristics @ T_J = 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 = 1.0mA
ΔBV _{DSS} /ΔT _J	Breakdown Voltage Temp. Coefficient	—	0.29	—	V/°C	Reference to 25°C, I _D = 1.0mA
R _{DS(on)}	Static Drain-to-Source On-	—	—	0.061	Ω	V _{GS} = 12V, I _D = 23.5A ④
V _{GS(th)}	Gate Threshold Voltage	2.5	—	4.5	V	V _{DS} = V _{GS} , I _D = 1.0mA
g _{fs}	Forward Transconductance	27	—	—	S	V _{DS} = 15V, I _D = 23.5A ④
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	—	—	165	nC	I _D = 37A
Q _{GS}	Gate-to-Source Charge	—	—	45		V _{DS} = 125V
Q _{GD}	Gate-to-Drain ('Miller') Charge	—	—	75		V _{GS} = 12V
t _{d(on)}	Turn-On Delay Time	—	—	35	ns	V _{DD} = 125V
t _r	Rise Time	—	—	125		I _D = 37A
t _{d(off)}	Turn-Off Delay Time	—	—	80		R _G = 2.35Ω
t _f	Fall Time	—	—	65		V _{GS} = 12V
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	—	5410	—	pF	V _{GS} = 0V
C _{oss}	Output Capacitance	—	770	—		V _{DS} = 25V
C _{rss}	Reverse Transfer Capacitance	—	36	—		f = 1.0MHz
R _G	Gate Resistance	—	1.2	—	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)	—	—	37	A	
I _{SM}	Pulsed Source Current (Body Diode) ①	—	—	148		
V _{SD}	Diode Forward Voltage	—	—	1.2	V	T _J = 25°C, I _S = 37A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	—	560	ns	T _J = 25°C, I _F = 37A, V _{DD} ≤ 50V
Q _{rr}	Reverse Recovery Charge	—	—	8.2	μC	di/dt = 100A/μs ④
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L _S +L _D)				

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
R _{θJC}	Junction-to-Case	—	—	0.60	°C/W
R _{θCS}	Case -to-Sink	—	0.21	—	
R _{θJA}	Junction-to-Ambient (Typical Socket Mount)	—	—	48	

Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② V_{DD} = 50V, starting T_J = 25°C, L = 0.38mH, Peak I_L = 37A, V_{GS} = 12V
- ③ I_{SD} ≤ 37A, di/dt ≤ 1040A/μs, V_{DD} ≤ 250V, T_J ≤ 150°C
- ④ Pulse width ≤ 300 μs; Duty Cycle ≤ 2%
- ⑤ **Total Dose Irradiation with V_{GS} Bias.** 12 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.

Radiation Characteristics

IR HiRel 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.

Table1. Electrical Characteristics @ $T_j = 25^\circ\text{C}$, Post Total Dose Irradiation ⑤⑥

	Parameter	100 kRads(Si)		Units	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	4.5	V	$V_{DS} = V_{GS}, I_D = 1.0mA$
I_{GSS}	Gate-to-Source Leakage Forward	—	100	nA	$V_{GS} = 20V$
I_{GSS}	Gate-to-Source Leakage Reverse	—	-100	nA	$V_{GS} = -20V$
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)	—	0.061	Ω	$V_{GS} = 12V, I_D = 23.5A$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (Low Ohmic TO-254AA)	—	0.061	Ω	$V_{GS} = 12V, I_D = 23.5A$
V_{SD}	Diode Forward Voltage	—	1.2	V	$V_{GS} = 0V, I_D = 37A$

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. a and Table 2.

Table 2. Typical Single Event Effect Safe Operating Area

LET (MeV/(mg/cm ²))	Energy (MeV)	Range (μm)	VDS (V)				
			@ VGS = 0V	@ VGS=-5V	@ VGS=-10V	@ VGS =-15V	@ VGS=-20V
$38 \pm 5\%$	$300 \pm 7.5\%$	$38 \pm 7.5\%$	250	250	250	250	250
$61 \pm 5\%$	$330 \pm 7.5\%$	$31 \pm 10\%$	250	250	250	250	240
$84 \pm 5\%$	$350 \pm 7.5\%$	$28 \pm 7.5\%$	250	250	225	175	50

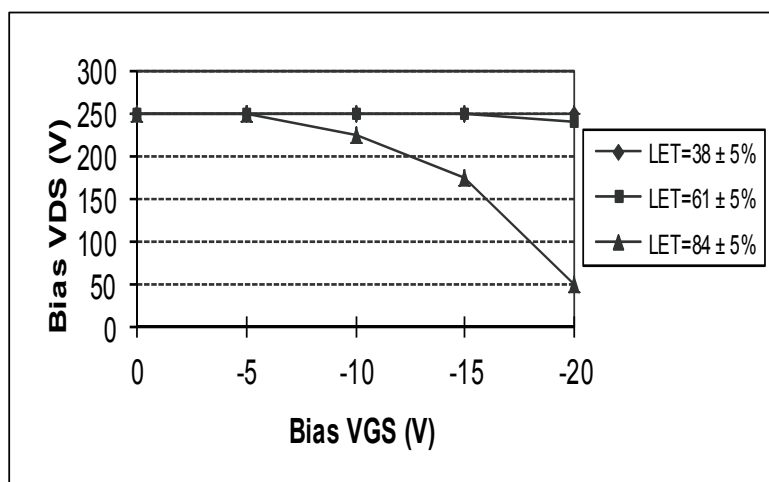
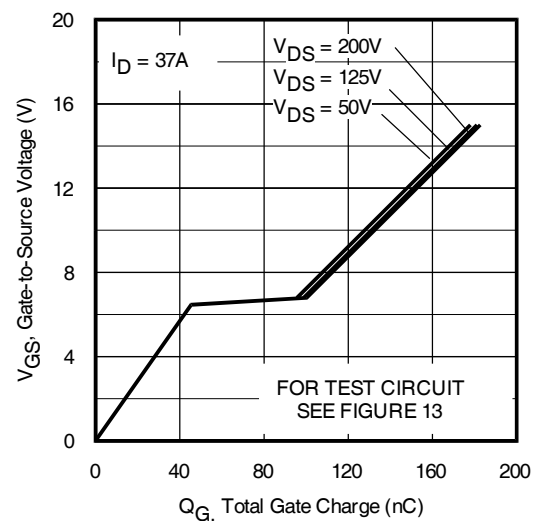
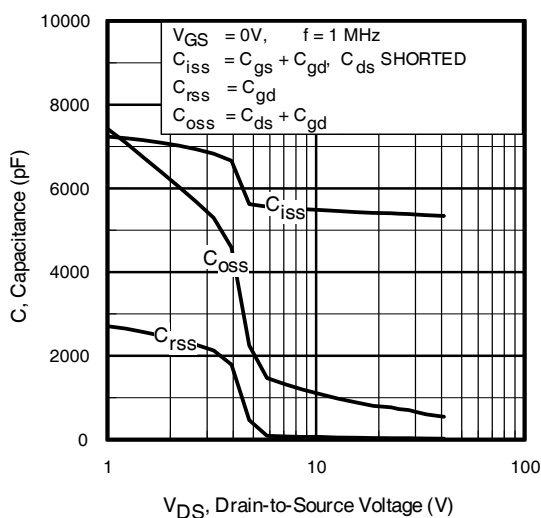
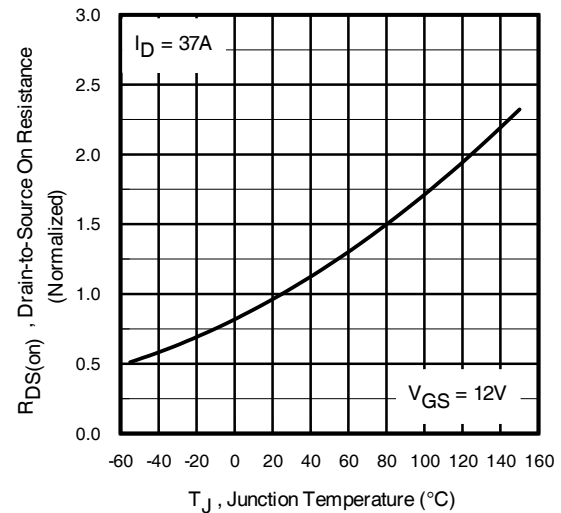
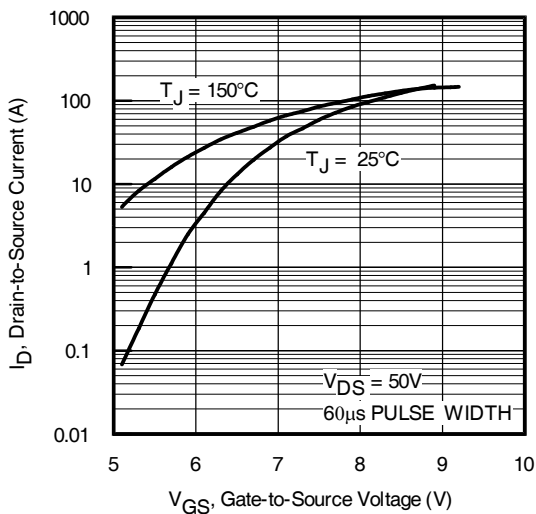
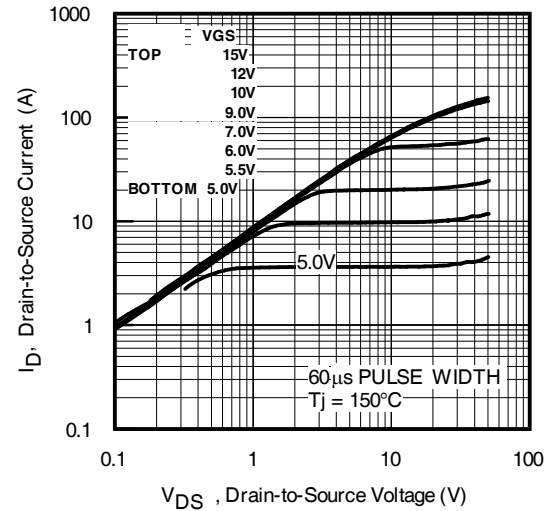
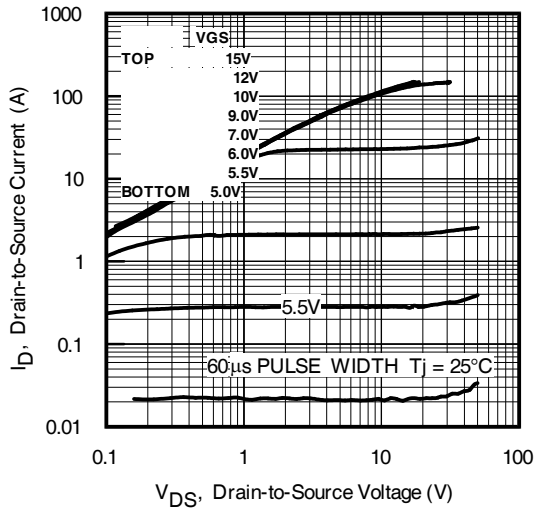


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the page 2.



Pre-Irradiation

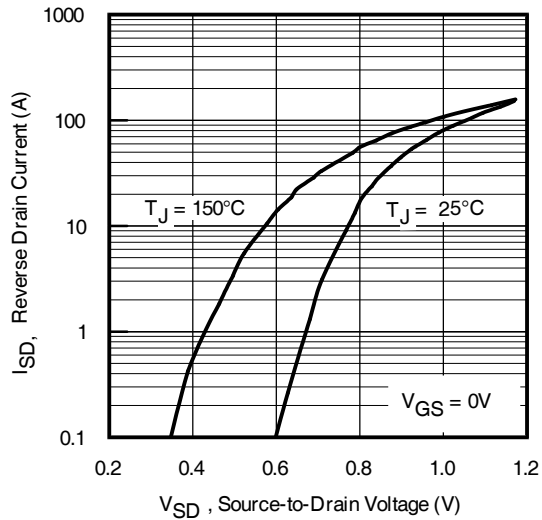


Fig 7. Typical Source-Drain Diode Forward Voltage

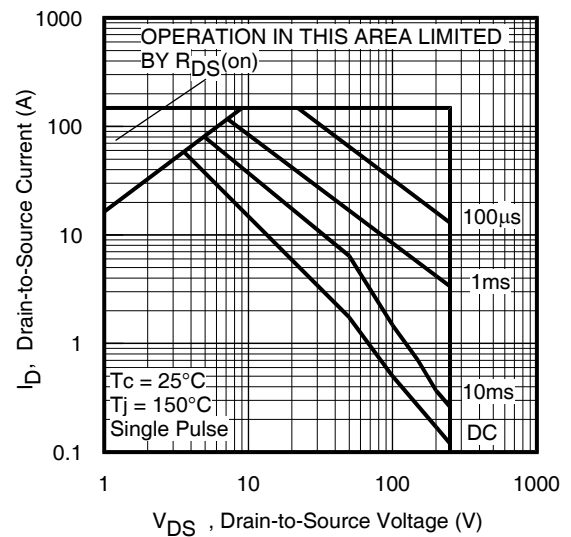


Fig 8. Maximum Safe Operating Area

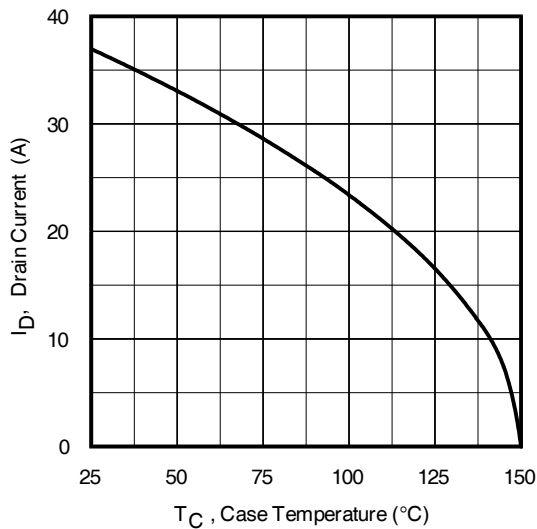


Fig 9 Maximum Drain Current Vs. Case Temperature

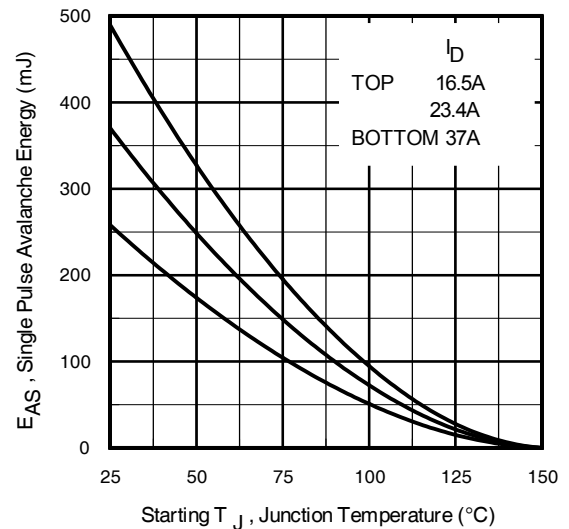


Fig 10. Maximum Avalanche Energy Vs. Drain Current

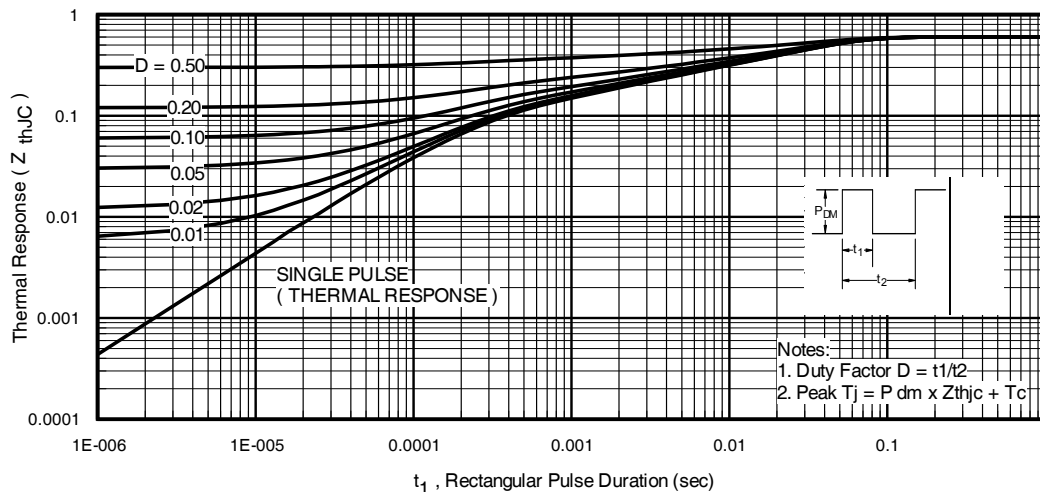


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

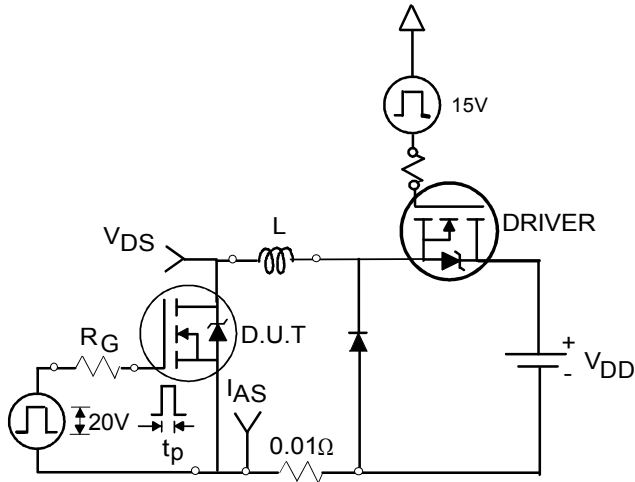


Fig 12a. Unclamped Inductive Test Circuit

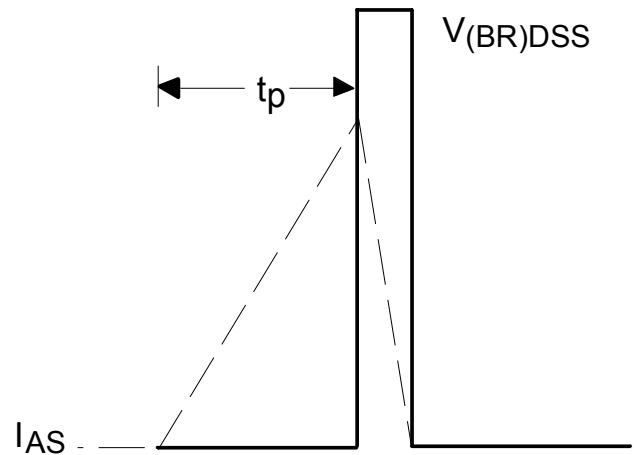


Fig 12b. Unclamped Inductive Waveforms

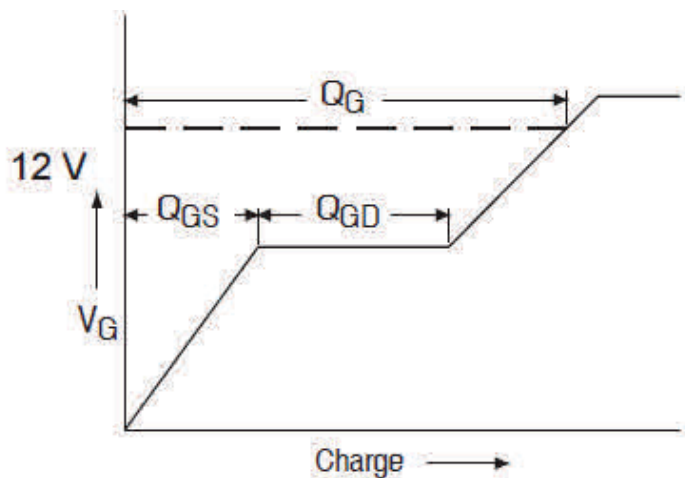


Fig 13a. Gate Charge Waveform

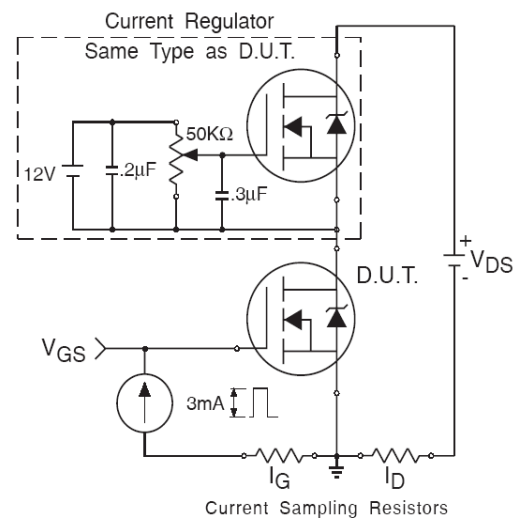


Fig 13b. Gate Charge Test Circuit

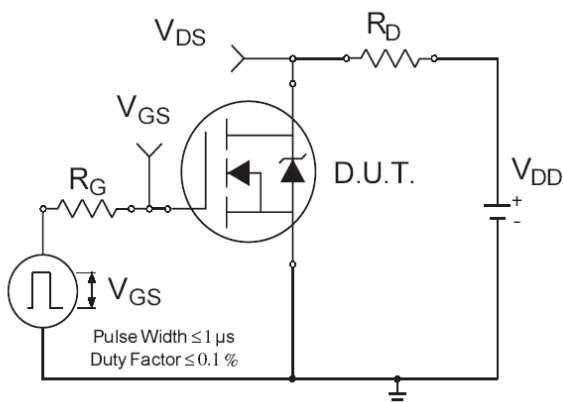


Fig 14a. Switching Time Test Circuit

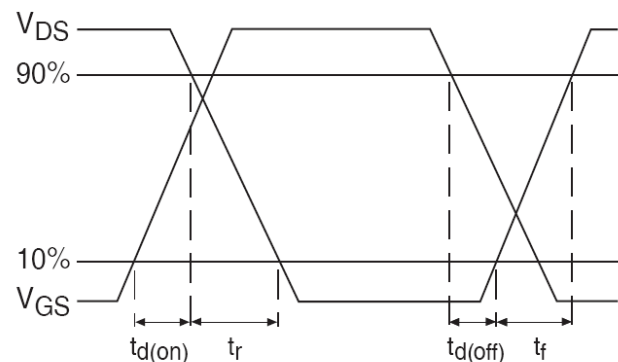
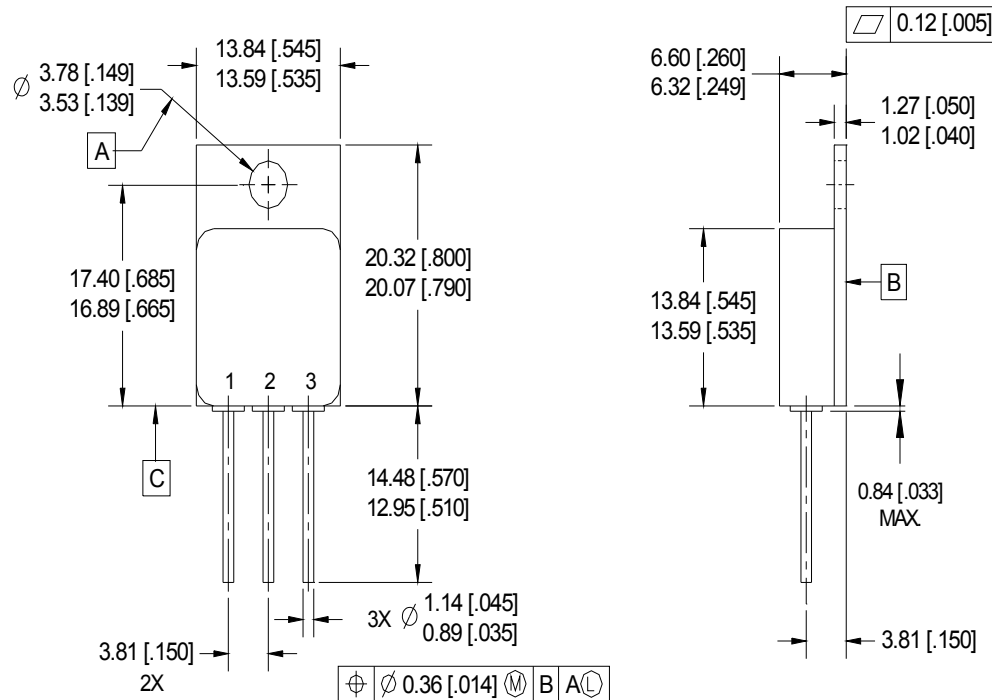


Fig 14b. Switching Time Waveforms

Case Outline and Dimensions - Low-Ohmic TO-254AA



NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. CONTROLLING DIMENSION: INCH.
4. CONFORMS TO JEDEC OUTLINE TO-254AA.

PIN ASSIGNMENTS

- 1 = DRAIN
- 2 = SOURCE
- 3 = GATE

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.

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