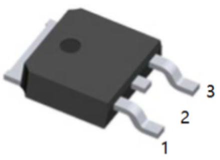
-60V P-Channel MOSFET

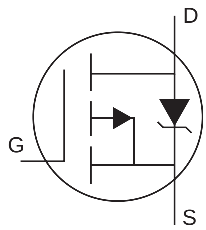
Description

- Advanced Process Technology
- Key Parameters Optimized for Class-D Audio Amplifier Applications
- Low R_{DSON} for Improved Efficiency
- Low Q_g and Q_{sw} for Better THD and Improved Efficiency
- Low Q_{rr} for Better THD and Lower EMI
- 175°C Operating Junction Temperature for Ruggedness
- Repetitive Avalanche Capability for Robustness and Reliability
- Multiple Package Options



1.G 2.D 3.S

TO-252(DPAK) top view



Features

- V_{DS}(V) = -60V
- $R_{DS(ON)}$ < 97mΩ(V_{GS}= -10V)
- $R_{DS(ON)}$ < 130mΩ (V_{GS} = -4.5V)

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{DS}	Drain-to-Source Voltage	-60	V
V_{GS}	Gate-to-Source Voltage	±20	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ -10V	-20	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	-14	
I_{DM}	Pulsed Drain Current ①	-60	
P_D @T_C = 25°C	Power Dissipation	79	W
P_D @T_C = 100°C	Power Dissipation	39	
	Linear Derating Factor	0.53	W/°C
T_J T_{STG}	Operating Junction and Storage Temperature Range	-40 to + 175	°C
	Clamping Pressure ⑥		N

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ⑤		1.9	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB Mounted) ⑤⑧		50	
$R_{\theta JA}$	Junction-to-Ambient (free air) ⑤		110	

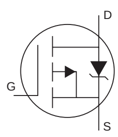
Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-55			V	V_{GS} = 0V, I_D = -250µA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient		-52		mV/°C	Reference to 25°C, I_D = -1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance		93	97	mΩ	V_{GS} = -10V, I_D = -3.4A ③
			100	130		V_{GS} = -4.5V, I_D = -2.7A ③
$V_{GS(th)}$	Gate Threshold Voltage	-1.1	-2	-3.0	V	V_{DS} = V_{GS}, I_D = -250µA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient		-3.7		mV/°C	
I_{DSS}	Drain-to-Source Leakage Current			-2.0	µA	V_{DS} = -55V, V_{GS} = 0V
				-25		V_{DS} = -55V, V_{GS} = 0V, T_J = 125°C
I_{GSS}	Gate-to-Source Forward Leakage			-100	nA	V_{GS} = -20V
	Gate-to-Source Reverse Leakage			100		V_{GS} = 20V
g_{fs}	Forward Transconductance	5.3			S	V_{DS} = -25V, I_D = -14A
Q_g	Total Gate Charge		31	47		V_{DS} = -44V
Q_{gs}	Gate-to-Source Charge		7.1			V_{GS} = -10V
Q_{gd}	Gate-to-Drain Charge		8.5			I_D = -14A
Q_{godr}	Gate Charge Overdrive		15			See Fig. 6 and 19
$t_{d(on)}$	Turn-On Delay Time		9.5			V_{DD} = -28V, V_{GS} = -10V ③
t_r	Rise Time		24			I_D = -14A
$t_{d(off)}$	Turn-Off Delay Time		21		ns	R_G = 2.5Ω
t_f	Fall Time		9.5			
C_{iss}	Input Capacitance		660			V_{GS} = 0V
C_{oss}	Output Capacitance		160		pF	V_{DS} = -50V
C_{rss}	Reverse Transfer Capacitance		72			*f* = 1.0MHz, See Fig.5
C_{oss}	Effective Output Capacitance		280			V_{GS} = 0V, V_{DS} = 0V to -44V
L_D	Internal Drain Inductance		4.5		nH	Between lead, 6mm (0.25in.)
L_S	Internal Source Inductance		7.5			from package and center of die contact ④

Avalanche Characteristics

	Parameter	Typ.	Max.	Units
E_{AS}	Single Pulse Avalanche Energy②		120	mJ
I_{AR}	Avalanche Current ⑦	See Fig. 14, 15, 17a, 17b		A
E_{AR}	Repetitive Avalanche Energy ⑦			mJ

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S @ T_C = 25°C	Continuous Source Current (Body Diode)			-20	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①			-60		
V_{SD}	Diode Forward Voltage			-1.2	V	T_J = 25°C, I_S = -14A, V_{GS} = 0V ③
t_{rr}	Reverse Recovery Time		57	86	ns	T_J = 25°C, I_F = -14A
Q_{rr}	Reverse Recovery Charge		120	180	nC	di/dt = 100A/µs ③

Notes:

① Repetitive rating; pulse width limited by max. junction temperature.

② Starting T_J = 25°C, L = 1.24mH, R_G = 25Ω, I_{AS} = -14A.

③ Pulse width ≤ 400µs; duty cycle ≤ 2%.

④ This only applies for I-Pak, L_S of D-Pak is measured between lead and center of die contact

⑤ R_θ is measured at T_J of approximately 90°C.

⑥ Contact factory for mounting information

⑦ Limited by Tjmax. See Figs. 14, 15, 17a, 17b for repetitive avalanche information

⑧ When D-Pak mounted on 1" square PCB (FR-4 or G-10 Material) . For recommended footprint and soldering techniques refer to application note #AN-994

⑨ Refer to D-Pak package for Part Marking, Tape and Reel information.

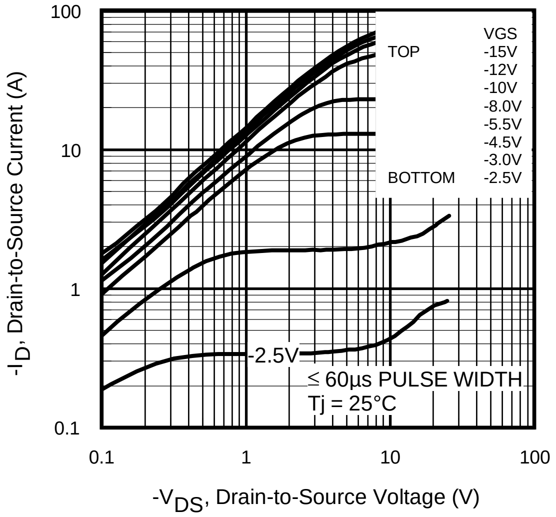


Fig 1. Typical Output Characteristics

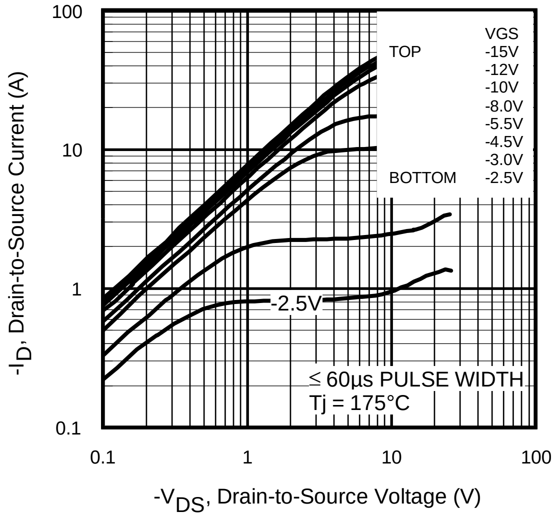


Fig 2. Typical Output Characteristics

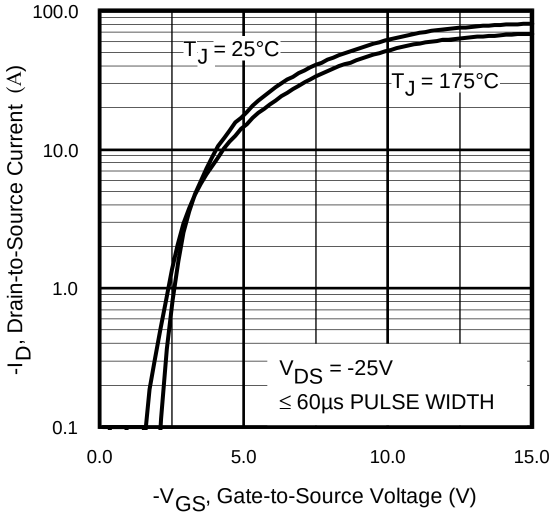


Fig 3. Typical Transfer Characteristics

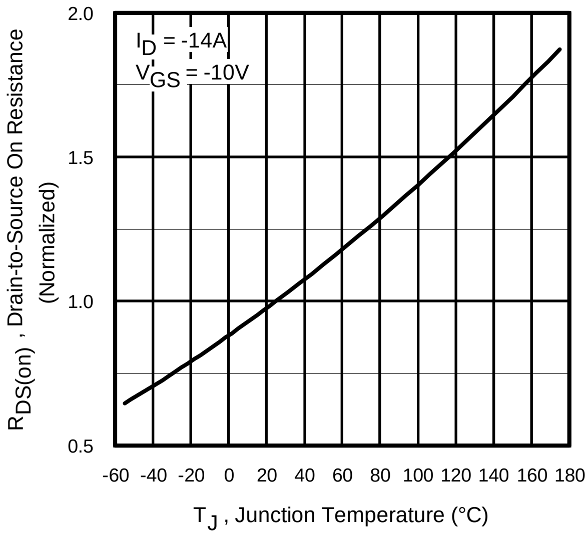
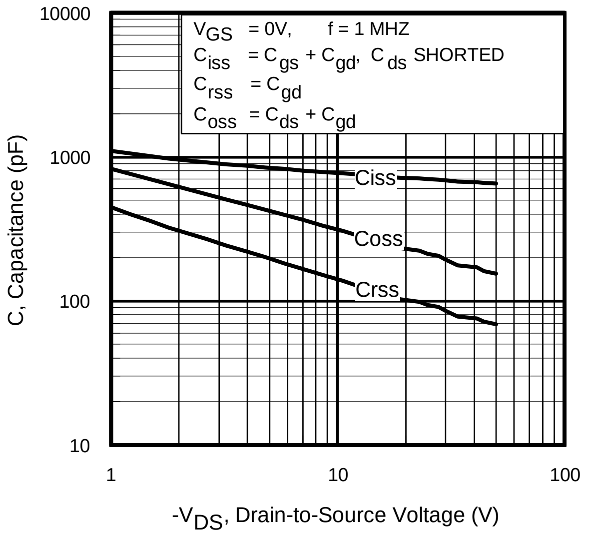
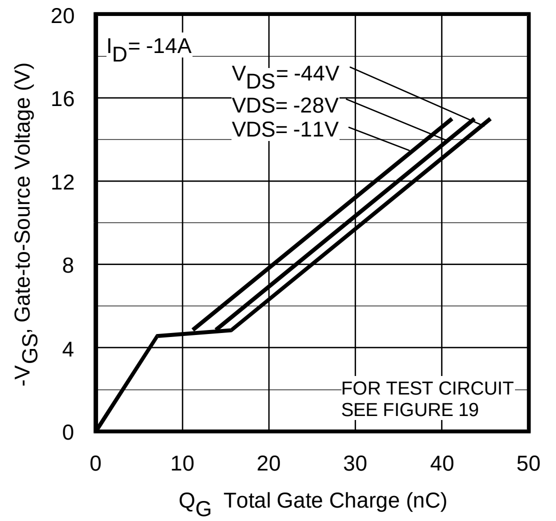


Fig 4. Normalized On-Resistance vs. Temperature





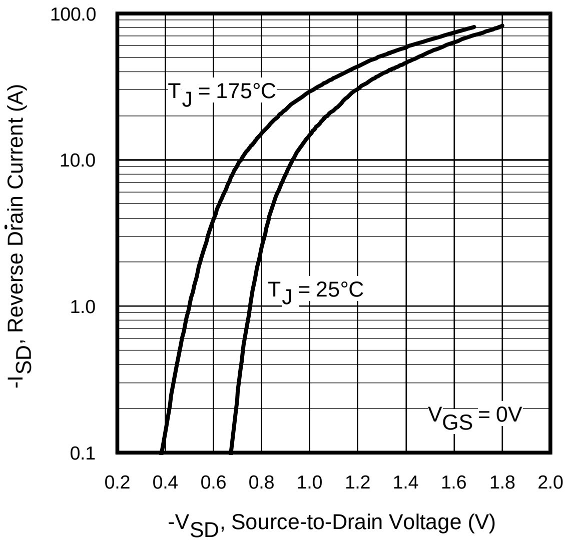


Fig 7. Typical Source-Drain Diode Forward Voltage

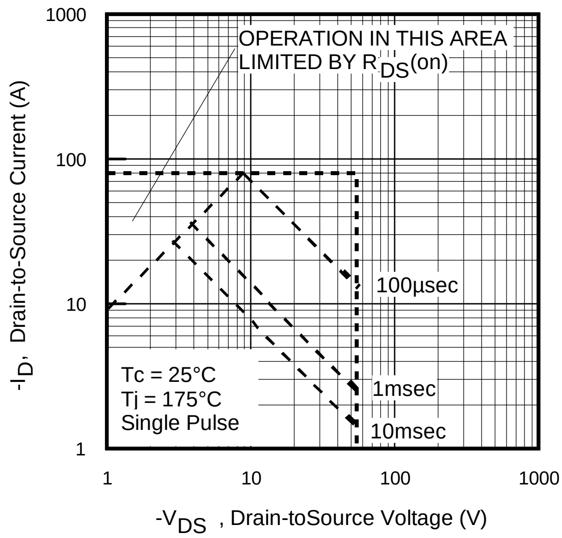


Fig 8. Maximum Safe Operating Area

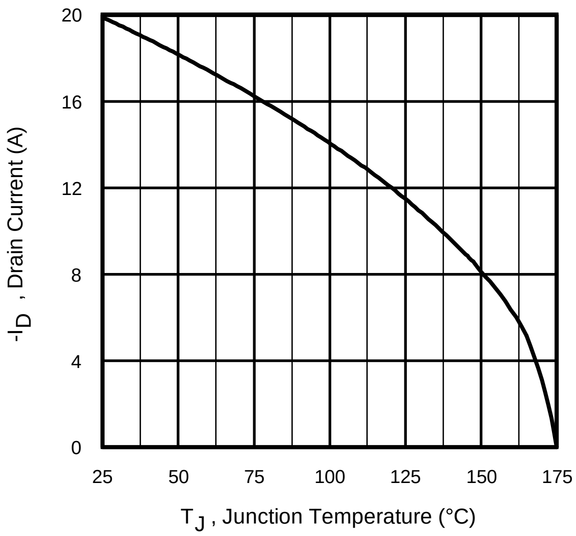


Fig 9. Maximum Drain Current vs. Case Temperature

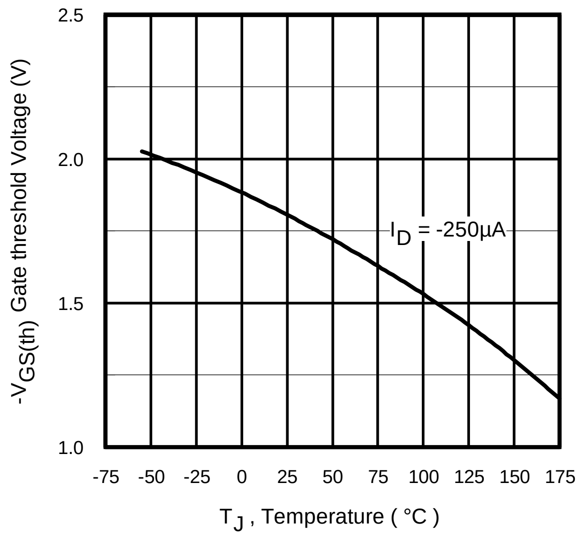
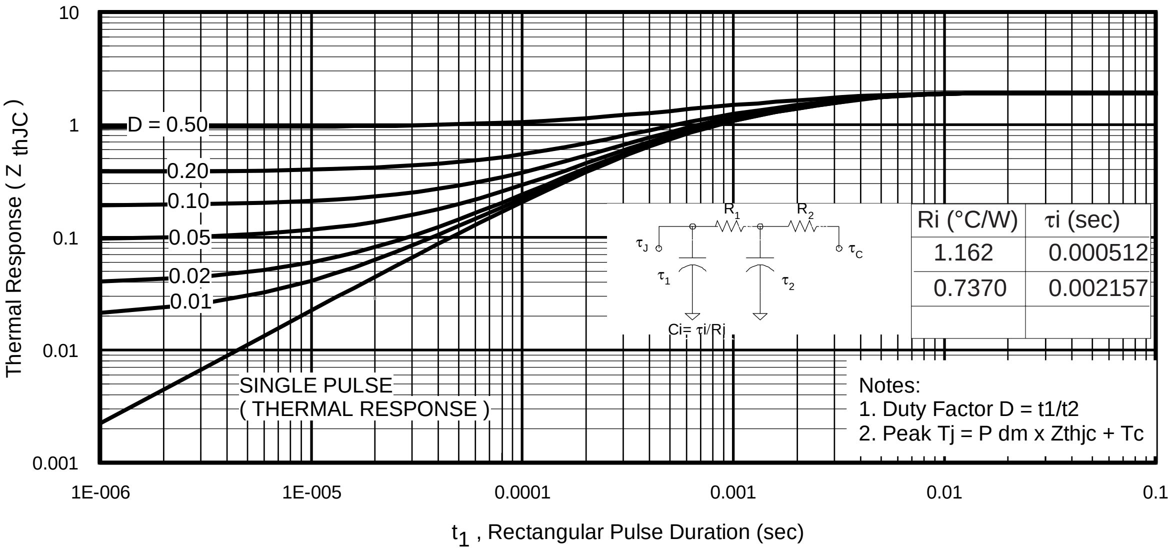
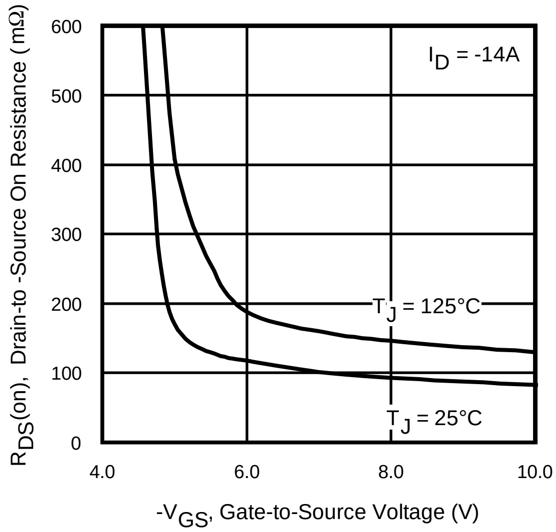


Fig 10. Threshold Voltage vs. Temperature


10
1
0.1
0.01
0.001
Thermal Response (Z thJC)
D = 0.50
0.20
0.10
0.05
0.02
0.01
SINGLE PULSE
(THERMAL RESPONSE)
Ri (°C/W) τi (sec)
1.162 0.000512
0.7370 0.002157
Ci= τi/Ri
Notes:
1. Duty Factor D = t1/t2
2. Peak Tj = P dm x Zthjc + Tc
1E-006
1E-005
0.0001
0.001
0.01
0.1
t1 , Rectangular Pulse Duration (sec)


RDS(on), Drain-to -Source On Resistance (mΩ)
600
500
400
300
200
100
0
ID = -14A
TJ = 125°C
TJ = 25°C
4.0
6.0
8.0
10.0
-VGS, Gate-to-Source Voltage (V)

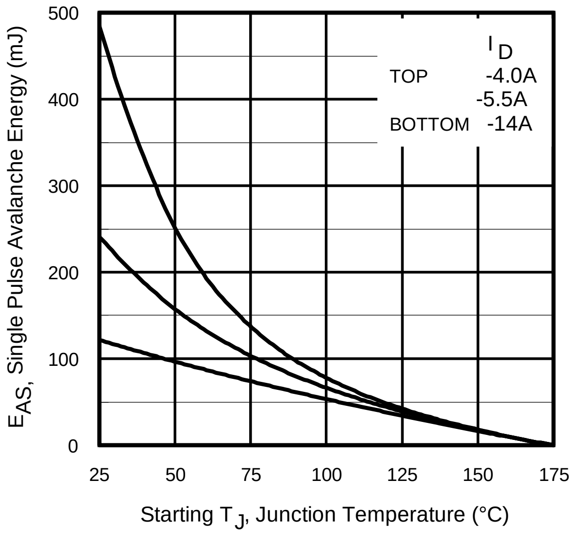

EAS, Single Pulse Avalanche Energy (mJ)
500
400
300
200
100
0
ID
TOP -4.0A
-5.5A
BOTTOM -14A
25
50
75
100
125
150
175
Starting TJ, Junction Temperature (°C)

Fig 12. On-Resistance Vs. Gate Voltage

Fig 13. Maximum Avalanche Energy Vs. Drain Current

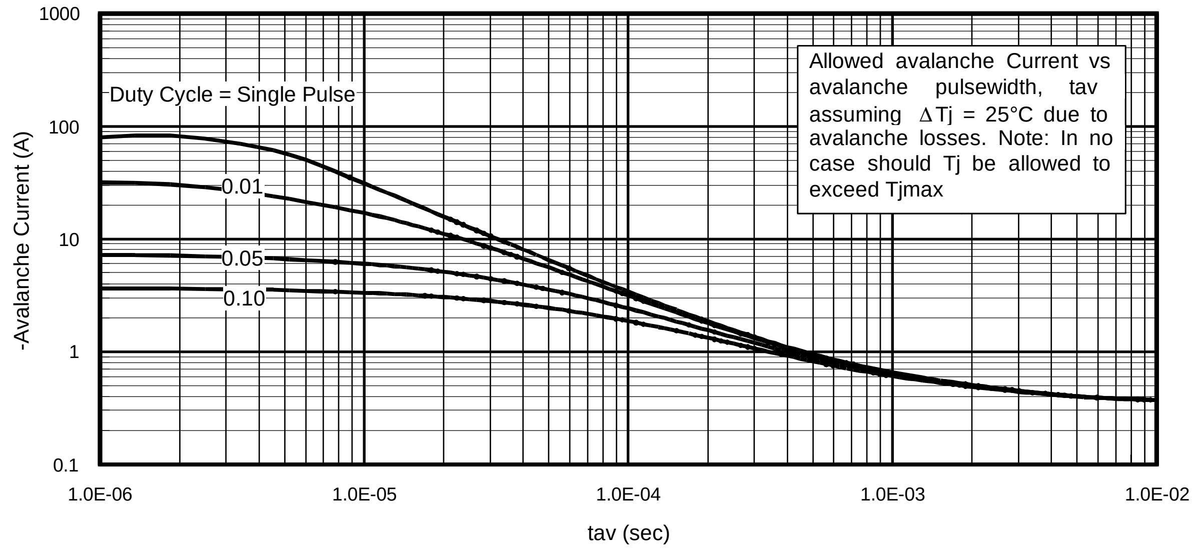


Fig 14. Typical Avalanche Current Vs.Pulsewidth

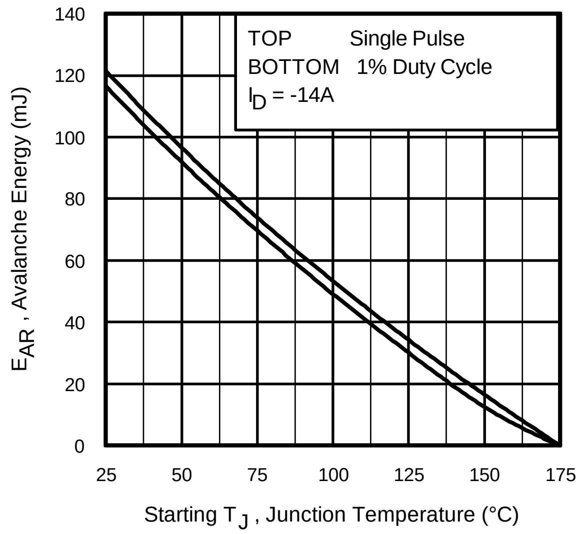


Fig 15. Maximum Avalanche Energy Vs. Temperature

Notes on Repetitive Avalanche Curves , Figures 14, 15:

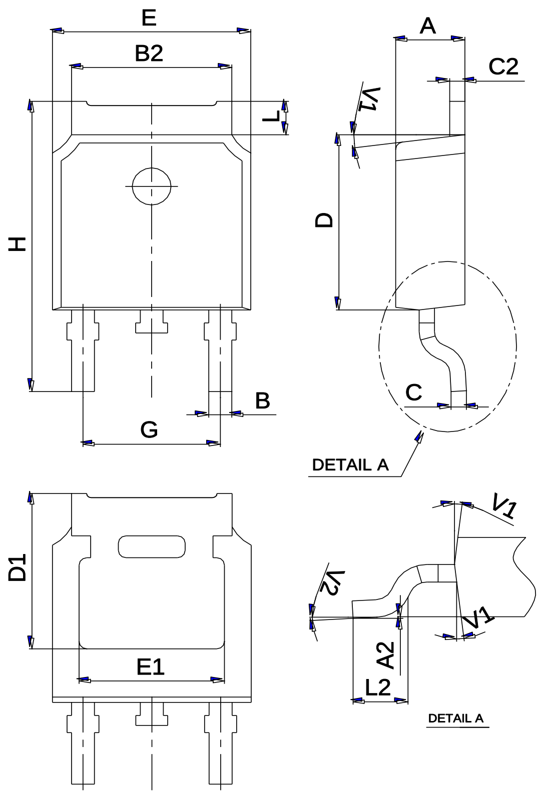
1. Avalanche failures assumption:
   Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax}. This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 17a, 17b.
4. $P_{D\ (ave)}$ = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6. I_{av} = Allowable avalanche current.
7. ΔT = Allowable rise in junction temperature, not to exceed T_{jmax} (assumed as 25°C in Figure 14, 15).
   t_{av} = Average time in avalanche.
   D = Duty cycle in avalanche = $t_{av} \cdot f$
   $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see figure 11)

$$\mathbf{P_{D\ (ave)} = 1/2\ (\ 1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}}$$

$$\mathbf{I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]}$$

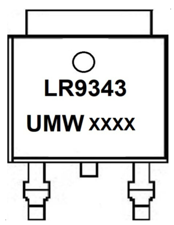
$$\mathbf{E_{AS\ (AR)} = P_{D\ (ave)} \cdot t_{av}}$$

Package Mechanical Data TO-252



Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.10		2.50	0.083		0.098
A2	0		0.10	0		0.004
B	0.66		0.86	0.026		0.034
B2	5.18		5.48	0.202		0.216
C	0.40		0.60	0.016		0.024
C2	0.44		0.58	0.017		0.023
D	5.90		6.30	0.232		0.248
D1	5.30REF			0.209REF		
E	6.40		6.80	0.252		0.268
E1	4.63			0.182		
G	4.47		4.67	0.176		0.184
H	9.50		10.70	0.374		0.421
L	1.09		1.21	0.043		0.048
L2	1.35		1.65	0.053		0.065
V1		7°			7°	
V2	0°		6°	0°		6°

Marking



Ordering information

Order code	Package	Baseqty	Deliverymode
UMW IRLR9343TR	TO-252	2500	Tape and reel