

## N-Channel 60 V (D-S), MOSFET

PRODUCT SUMMARY			
$V_{DS}$ (V)	$R_{DS(on)}$ ( $\Omega$ )	$I_D$ (A) <sup>a</sup>	$Q_g$ (Typ.)
60	0.031 at $V_{GS} = 10$ V	9.1	6.5 nC
	0.045 at $V_{GS} = 4.5$ V	7.6	

### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET<sup>®</sup> Power MOSFET
- 100 %  $R_g$  and UIS Tested
- Compliant to RoHS Directive 2002/95/EC

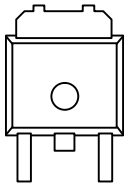


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### APPLICATIONS

- DC/DC Converters

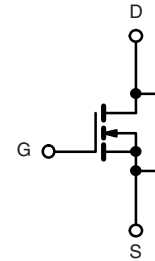
TO-252



G D S

Top View

Drain Connected to Tab



N-Channel MOSFET

Ordering Information: SUD23N06-31-GE3 (Lead (Pb)-free and Halogen-free)

ABSOLUTE MAXIMUM RATINGS ( $T_A = 25$ °C, unless otherwise noted)				
Parameter	Symbol	Limit	Unit	
Drain-Source Voltage	$V_{DS}$	60	V	
Gate-Source Voltage	$V_{GS}$	$\pm 20$		
Continuous Drain Current ( $T_J = 150$ °C)	$I_D$	$T_C = 25$ °C	21.4	A
		$T_C = 70$ °C	17.1	
		$T_A = 25$ °C	9.1 <sup>a</sup>	
		$T_A = 70$ °C	7.6 <sup>a</sup>	
Pulsed Drain Current	$I_{DM}$	50		
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25$ °C	20.8	
		$T_A = 25$ °C	3.8 <sup>a</sup>	
Single Pulse Avalanche Current	$I_{AS}$	20		
Avalanche Energy	$E_{AS}$	20	mJ	
Maximum Power Dissipation	$P_D$	$T_C = 25$ °C	31.25	W
		$T_C = 70$ °C	20	
		$T_A = 25$ °C	5.7 <sup>a</sup>	
		$T_A = 70$ °C	3.6 <sup>a</sup>	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to 150	°C	

### THERMAL RESISTANCE RATINGS

Parameter	Symbol	Typical	Maximum	Unit
Maximum Junction-to-Ambient <sup>a</sup>	$R_{thJA}$	18	22	°C/W
Maximum Junction-to-Case	$R_{thJC}$	3.2	4.0	

Notes:

a. Surface mounted on 1" x 1" FR4 board,  $t \leq 10$  s.

<b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>Static</b>						
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$	60			V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = 250\text{ }\mu\text{A}$		65		mV/ $^\circ\text{C}$
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$		-6.3			
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	1.0		3.0	V
Gate-Source Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}, T_J = 70\text{ }^\circ\text{C}$			20	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{DS} \geq 5\text{ V}, V_{GS} = 10\text{ V}$	50			A
Drain-Source On-State Resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 15\text{ A}$		0.025	0.031	$\Omega$
		$V_{GS} = 4.5\text{ V}, I_D = 10\text{ A}$		0.037	0.045	
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = 15\text{ V}, I_D = 15\text{ A}$		20		S
<b>Dynamic<sup>b</sup></b>						
Input Capacitance	$C_{ISS}$	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		670		$\mu\text{F}$
Output Capacitance	$C_{OSS}$		140			
Reverse Transfer Capacitance	$C_{RSS}$		60			
Total Gate Charge	$Q_g$	$V_{DS} = 30\text{ V}, V_{GS} = 10\text{ V}, I_D = 23\text{ A}$		11	17	nC
			$V_{DS} = 30\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 23\text{ A}$		6.5	
$Q_{gs}$		3.0				
$Q_{gd}$		3.0				
Gate Resistance	$R_g$	$f = 1\text{ MHz}$		1.6	3.2	$\Omega$
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 30\text{ V}, R_L = 1.3\text{ }\Omega$ $I_D \cong 23\text{ A}, V_{GEN} = 4.5\text{ V}, R_g = 1\text{ }\Omega$		18	30	ns
Rise Time	$t_r$			250	400	
Turn-Off Delay Time	$t_{d(off)}$			35	55	
Fall Time	$t_f$			68	110	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 30\text{ V}, R_L = 1.3\text{ }\Omega$ $I_D \cong 23\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\text{ }\Omega$		8	15	
Rise Time	$t_r$			15	25	
Turn-Off Delay Time	$t_{d(off)}$			30	45	
Fall Time	$t_f$			25	40	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25\text{ }^\circ\text{C}$			20.8	A
Pulse Diode Forward Current <sup>a</sup>	$I_{SM}$				50	
Body Diode Voltage	$V_{SD}$	$I_S = 15\text{ A}$		1.0	1.5	V
Body Diode Reverse Recovery Time	$t_{rr}$	$I_F = 15\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^\circ\text{C}$		30	60	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			35	70	nC
Reverse Recovery Fall Time	$t_a$			20		ns
Reverse Recovery Rise Time	$t_b$			10		

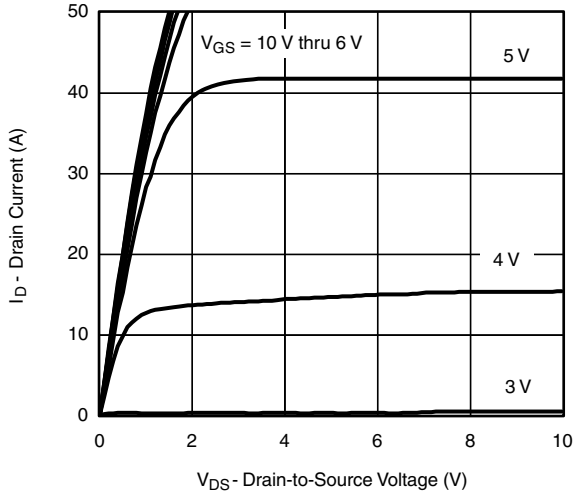
Notes:

a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

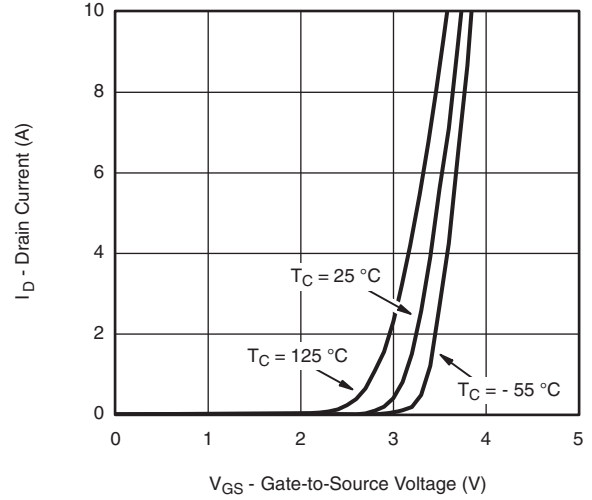
b. Guaranteed by design, not subject to production testing.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

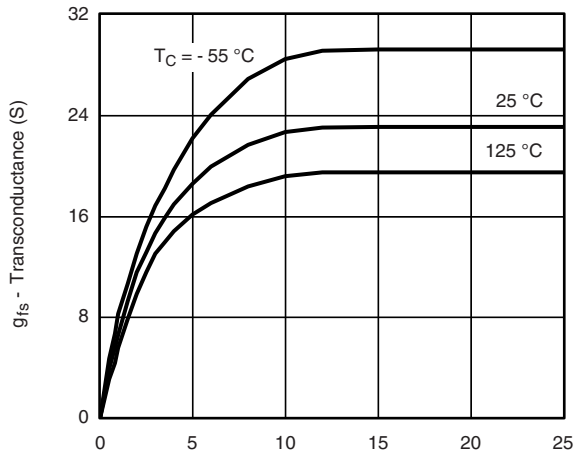
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



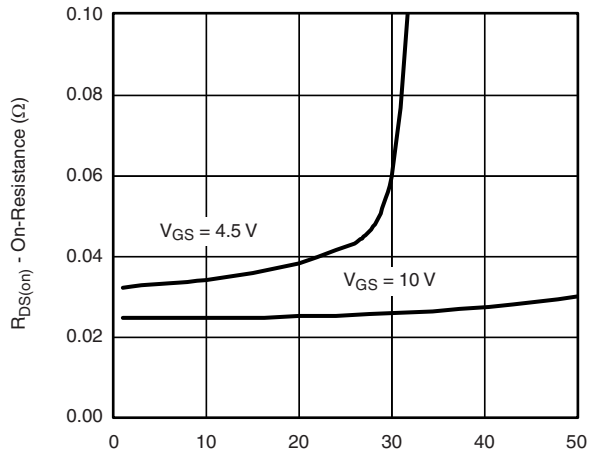
**Output Characteristics**



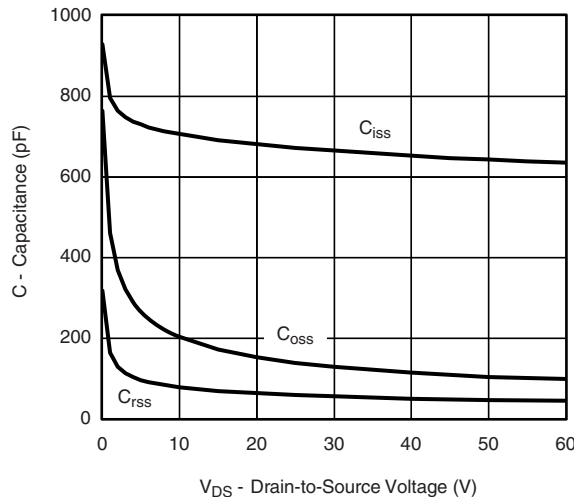
**Transfer Characteristics**



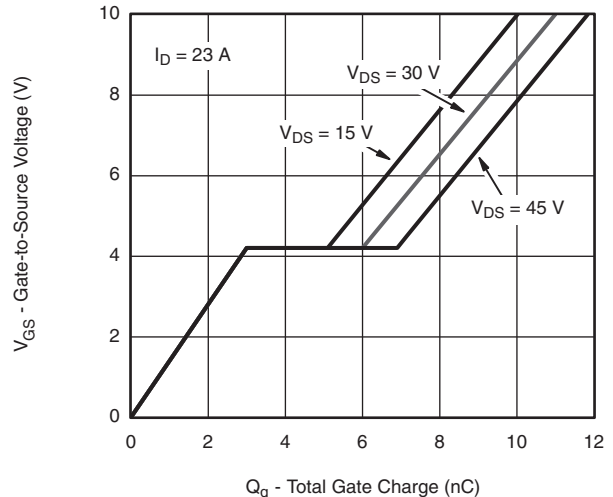
**Transconductance**



**On-Resistance vs. Drain Current**

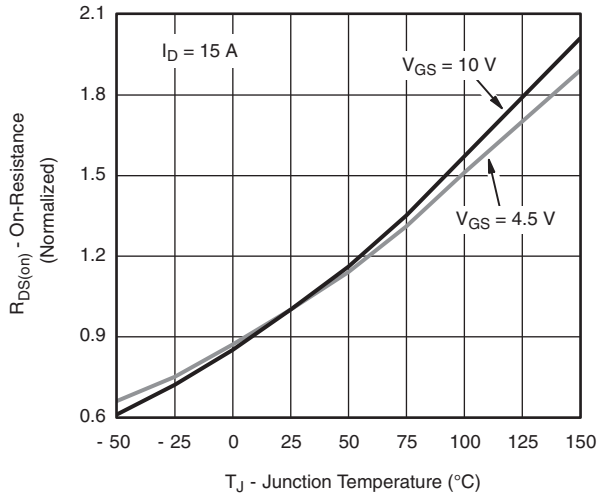


**Capacitance**

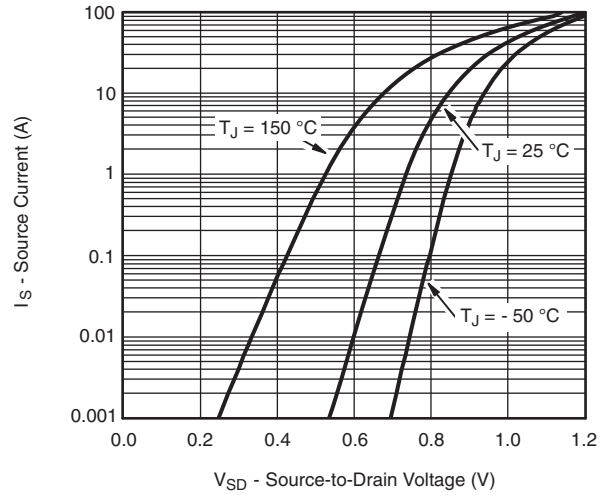


**Gate Charge**

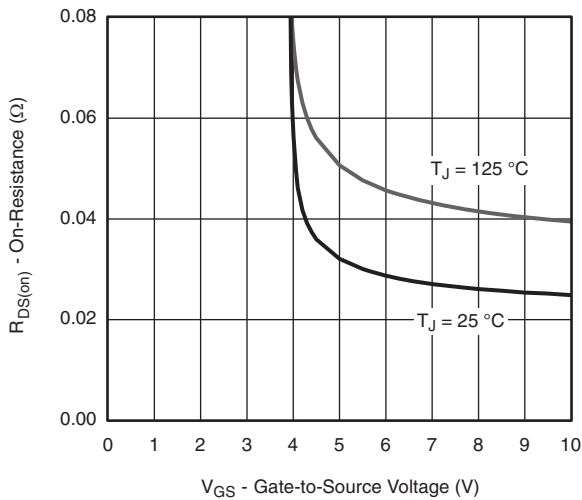
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



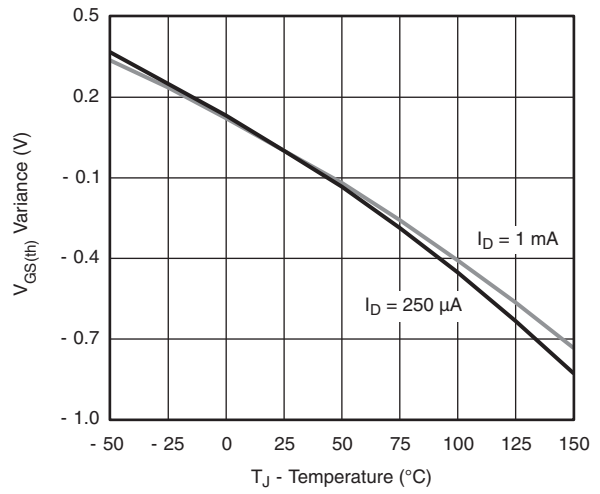
**On-Resistance vs. Junction Temperature**



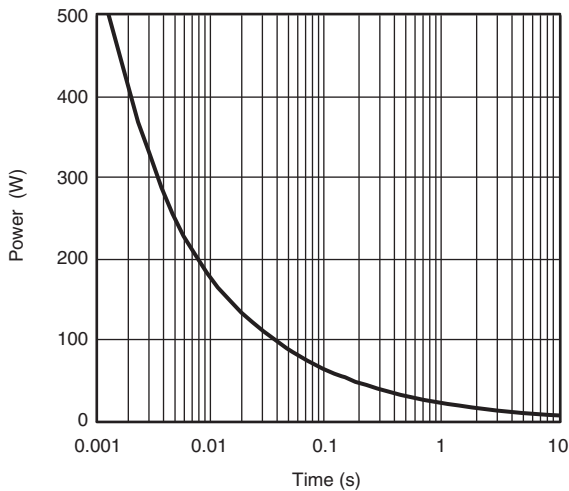
**Source-Drain Diode Forward Voltage**



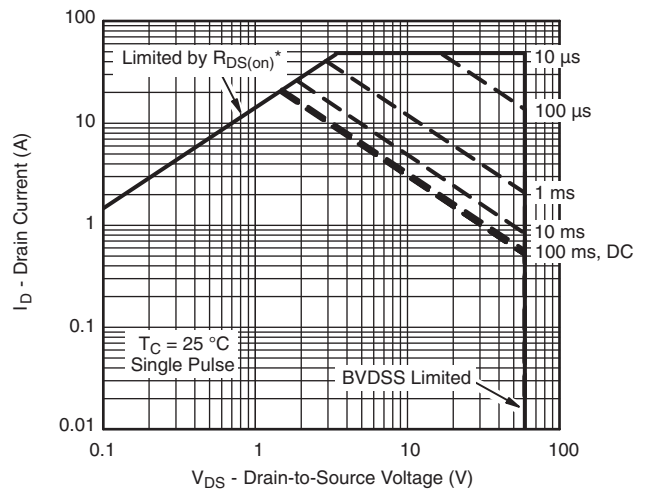
**On-Resistance vs. Gate-to-Source Voltage**



**Threshold Voltage**



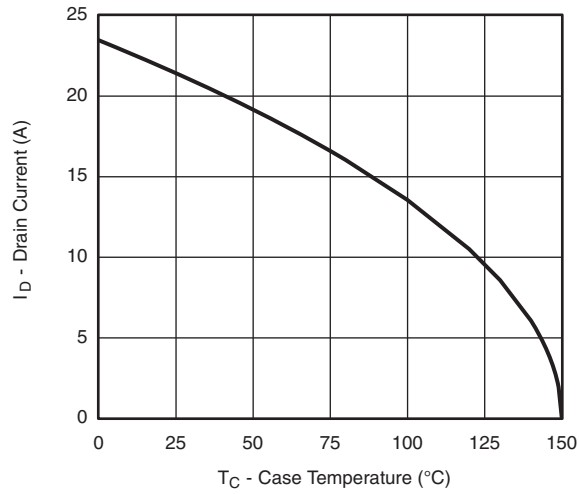
**Single Pulse Power, Junction-to-Ambient**



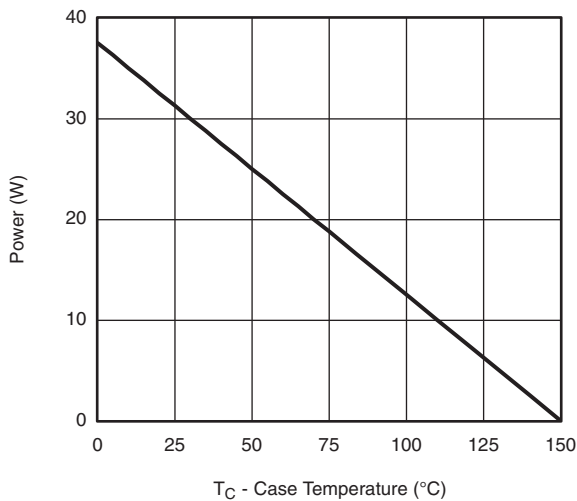
\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

**Single Pulse Power, Junction-to-Case**

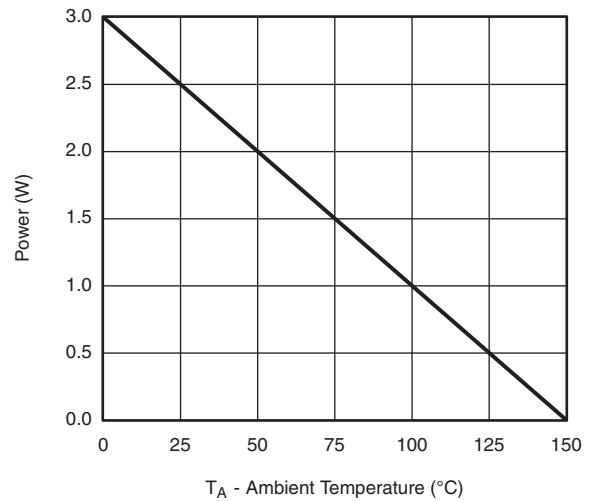
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



**Current Derating\*, Junction-to-Case**



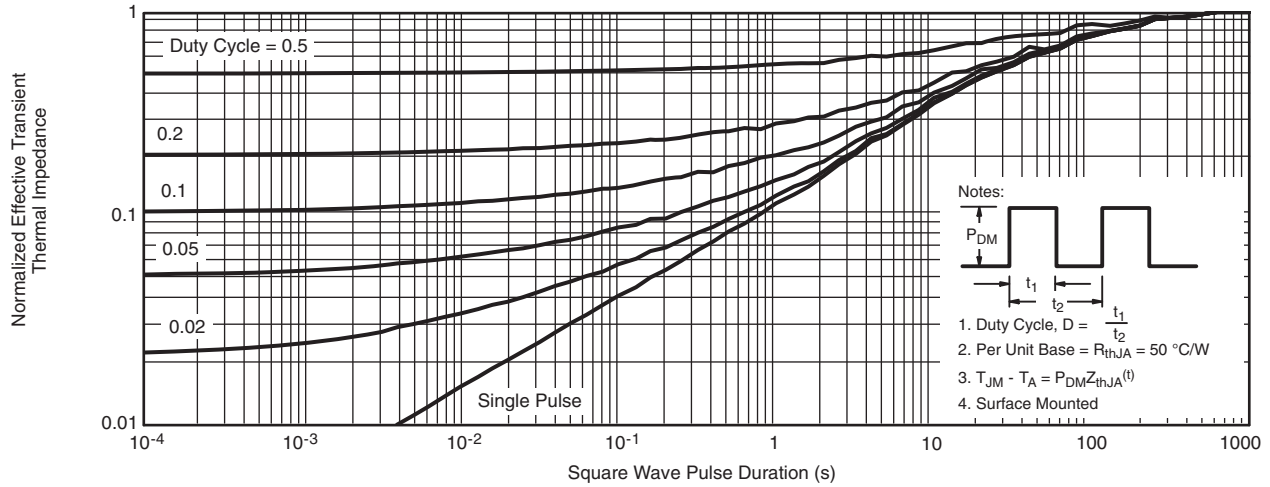
**Power, Junction-to-Case**



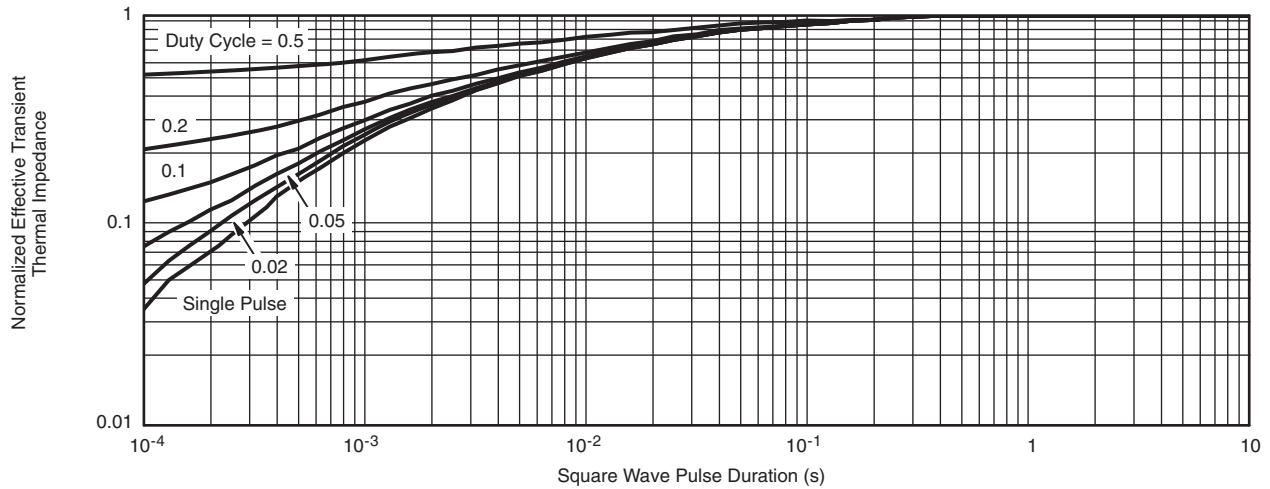
**Power, Junction-to-Ambient**

\* The power dissipation  $P_D$  is based on  $T_{J(max)} = 150$  °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



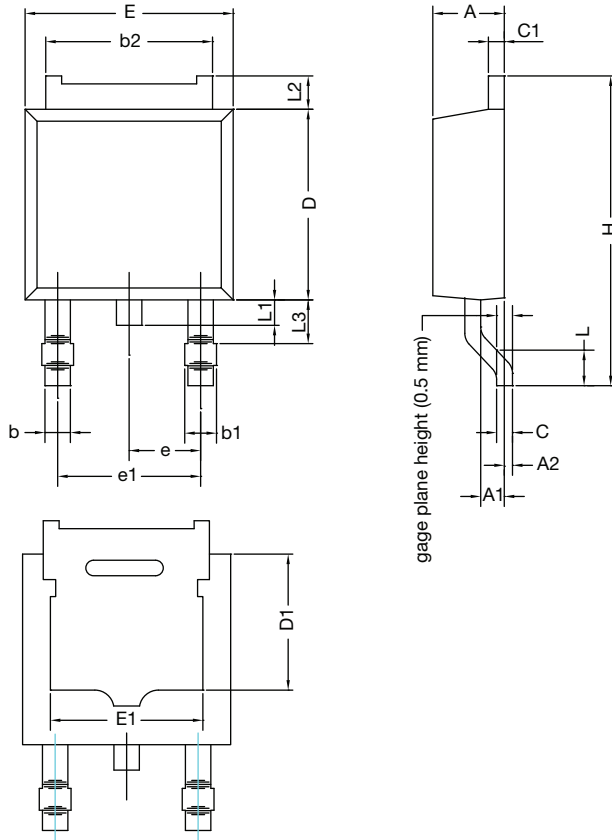
**Normalized Thermal Transient Impedance, Junction-to-Ambient**



**Normalized Thermal Transient Impedance, Junction-to-Case**

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## TO-252AA CASE OUTLINE



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	2.21	2.38	0.087	0.094
A1	0.89	1.14	0.035	0.045
A2	0.030	0.127	0.001	0.005
b	0.71	0.88	0.028	0.035
b1	0.76	1.14	0.030	0.045
b2	5.23	5.44	0.206	0.214
C	0.46	0.58	0.018	0.023
C1	0.46	0.58	0.018	0.023
D	5.97	6.22	0.235	0.245
D1	4.10	4.45	0.161	0.175
E	6.48	6.73	0.255	0.265
E1	4.49	5.50	0.177	0.217
e	2.28 BSC		0.090 BSC	
e1	4.57 BSC		0.180 BSC	
H	9.65	10.41	0.380	0.410
L	1.40	1.78	0.055	0.070
L1	0.64	1.02	0.025	0.040
L2	0.89	1.27	0.035	0.050
L3	1.15	1.52	0.040	0.060
ECN: T11-0110-Rev. L, 18-Apr-11 DWG: 5347				

### Note

- Dimension L3 is for reference only.

## RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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