

## N- and P-Channel 40-V (D-S) MOSFET

PRODUCT SUMMARY				
	V <sub>DS</sub> (V)	R <sub>DS(on)</sub> (Ω)	I <sub>D</sub> (A) <sup>a</sup>	Q <sub>g</sub> (Typ.)
N-Channel	40	0.0355 at V <sub>GS</sub> = 10 V	6.8	5.3
		0.0425 at V <sub>GS</sub> = 4.5 V	6.2	
P-Channel	- 40	0.035 at V <sub>GS</sub> = - 10 V	- 7.2	17
		0.047 at V <sub>GS</sub> = - 4.5 V	- 6.2	

### FEATURES

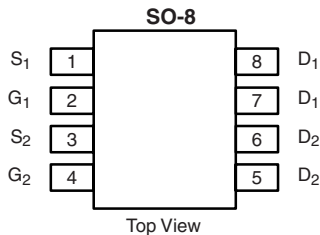
- Halogen-free According to IEC 61249-2-21 Available
- TrenchFET<sup>®</sup> Power MOSFET



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

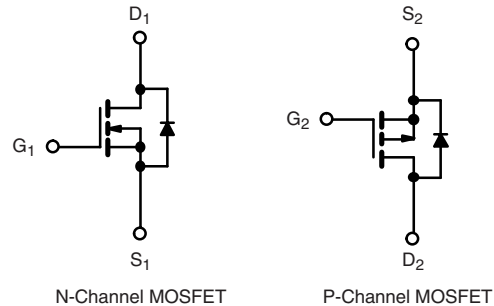
### APPLICATIONS

- Backlight Inverter for LCD Display



Top View

Ordering Information: Si4561DY-T1-E3 (Lead (Pb)-free)  
Si4561DY-T1-GE3 (Lead (Pb)-free and Halogen-free)



### ABSOLUTE MAXIMUM RATINGS T<sub>A</sub> = 25 °C, unless otherwise noted

Parameter	Symbol	N-Channel	P-Channel	Unit	
Drain-Source Voltage	V <sub>DS</sub>	40	- 40	V	
Gate-Source Voltage	V <sub>GS</sub>	± 20			
Continuous Drain Current (T <sub>J</sub> = 150 °C)	I <sub>D</sub>	T <sub>C</sub> = 25 °C	6.8	- 7.2	A
		T <sub>C</sub> = 70 °C	5.4	- 5.7	
		T <sub>A</sub> = 25 °C	5.6 <sup>b, c</sup>	- 5.6 <sup>b, c</sup>	
		T <sub>A</sub> = 70 °C	4.4 <sup>b, c</sup>	- 4.4 <sup>b, c</sup>	
Pulsed Drain Current	I <sub>DM</sub>	20	- 20	A	
Source-Drain Current Diode Current	I <sub>S</sub>	T <sub>C</sub> = 25 °C	2.5		- 2.5
		T <sub>A</sub> = 25 °C	1.6 <sup>b, c</sup>		- 1.6 <sup>b, c</sup>
Pulsed Source-Drain Current	I <sub>SM</sub>	20	- 20	mJ	
Single Pulse Avalanche Current	I <sub>AS</sub>	7	15		
Single Pulse Avalanche Energy	E <sub>AS</sub>	2.45	11.25	W	
Maximum Power Dissipation	P <sub>D</sub>	T <sub>C</sub> = 25 °C	3.0		3.3
		T <sub>C</sub> = 70 °C	1.9		2.10
		T <sub>A</sub> = 25 °C	2.0 <sup>b, c</sup>		2.0 <sup>b, c</sup>
		T <sub>A</sub> = 70 °C	1.25 <sup>b, c</sup>	1.25 <sup>b, c</sup>	
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	- 55 to 150		°C	

### THERMAL RESISTANCE RATINGS

Parameter	Symbol	N-Channel		P-Channel		Unit
		Typ.	Max.	Typ.	Max.	
Maximum Junction-to-Ambient <sup>b, d</sup>	R <sub>thJA</sub>	54	64	50	62.5	°C/W
Maximum Junction-to-Foot (Drain)	R <sub>thJF</sub>	33	42	31	37	

Notes:

- Based on T<sub>C</sub> = 25 °C.
- Surface Mounted on 1" x 1" FR4 board.
- t = 10 s.
- Maximum under Steady State conditions is 120 °C/W.

<b>SPECIFICATIONS</b> $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted							
Parameter	Symbol	Test Conditions	Min.	Typ. <sup>a</sup>	Max.	Unit	
<b>Static</b>							
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$	N-Ch	40		V	
		$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$	P-Ch	-40			
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = 250\text{ }\mu\text{A}$	N-Ch		44	mV/ $^\circ\text{C}$	
		$I_D = -250\text{ }\mu\text{A}$	P-Ch		-41		
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$	$I_D = 250\text{ }\mu\text{A}$	N-Ch		-5.5		
		$I_D = -250\text{ }\mu\text{A}$	P-Ch		4.3		
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	N-Ch	1.4		3.0	V
		$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$	P-Ch	-1.4		-3.0	
Gate-Body Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$	N-Ch			100	nA
			P-Ch			-100	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$	N-Ch			1	$\mu\text{A}$
		$V_{DS} = -40\text{ V}, V_{GS} = 0\text{ V}$	P-Ch			-1	
		$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$	N-Ch			10	
		$V_{DS} = -40\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$	P-Ch			-10	
On-State Drain Current <sup>b</sup>	$I_{D(on)}$	$V_{DS} = 5\text{ V}, V_{GS} = 10\text{ V}$	N-Ch	10			A
		$V_{DS} = -5\text{ V}, V_{GS} = -10\text{ V}$	P-Ch	-10			
Drain-Source On-State Resistance <sup>b</sup>	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 5\text{ A}$	N-Ch		0.0295	0.0355	$\Omega$
		$V_{GS} = -10\text{ V}, I_D = -5\text{ A}$	P-Ch		0.0285	0.035	
		$V_{GS} = 4.5\text{ V}, I_D = 4\text{ A}$	N-Ch		0.0355	0.0425	
		$V_{GS} = -4.5\text{ V}, I_D = -4\text{ A}$	P-Ch		0.037	0.047	
Forward Transconductance <sup>b</sup>	$g_{fs}$	$V_{DS} = 15\text{ V}, I_D = 5\text{ A}$	N-Ch		22		S
		$V_{DS} = -15\text{ V}, I_D = -5\text{ A}$	P-Ch		20		
<b>Dynamic<sup>a</sup></b>							
Input Capacitance	$C_{iss}$	N-Channel $V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch		640		pF
			P-Ch		1555		
Output Capacitance	$C_{oss}$	P-Channel $V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch		73		
			P-Ch		176		
Reverse Transfer Capacitance	$C_{rss}$		N-Ch		41		
			P-Ch		142		
Total Gate Charge	$Q_g$	$V_{DS} = 20\text{ V}, V_{GS} = 10\text{ V}, I_D = 5\text{ A}$	N-Ch		11.7	20	nC
		$V_{DS} = -20\text{ V}, V_{GS} = -10\text{ V}, I_D = -5\text{ A}$	P-Ch		38.5	60	
Gate-Source Charge	$Q_{gs}$	N-Channel $V_{DS} = 20\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 5\text{ A}$	N-Ch		5.3	9	
			P-Ch		17	27	
Gate-Drain Charge	$Q_{gd}$	P-Channel $V_{DS} = -20\text{ V}, V_{GS} = -4.5\text{ V}, I_D = -5\text{ A}$	N-Ch		1.9		
			P-Ch		4.2		
Gate Resistance	$R_g$	$f = 1\text{ MHz}$	N-Ch		2.2		$\Omega$
			P-Ch		3		



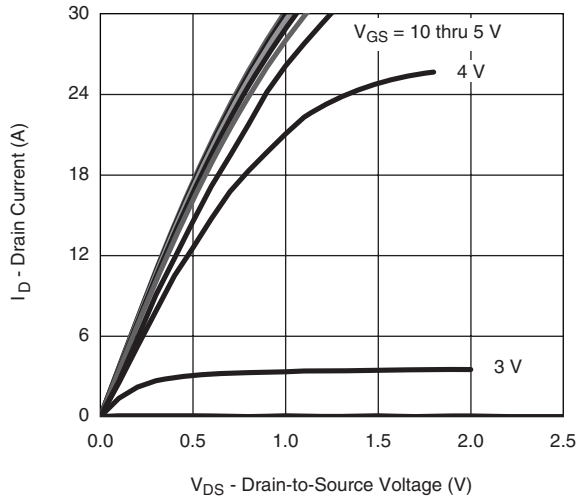
<b>SPECIFICATIONS</b> $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted								
Parameter	Symbol	Test Conditions	Min.	Typ. <sup>a</sup>	Max.	Unit		
<b>Dynamic<sup>a</sup></b>								
Turn-On Delay Time	$t_{d(on)}$	N-Channel $V_{DD} = 20\text{ V}$ , $R_L = 4\ \Omega$ $I_D \cong 5\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch		7	14	ns	
			P-Ch		11	20		
Rise Time	$t_r$		N-Ch		10	20		
			P-Ch		15	30		
Turn-Off Delay Time	$t_{d(off)}$	P-Channel $V_{DD} = -20\text{ V}$ , $R_L = 4\ \Omega$ $I_D \cong -5\text{ A}$ , $V_{GEN} = -10\text{ V}$ , $R_g = 1\ \Omega$	N-Ch		15	30		
			P-Ch		36	60		
Fall Time	$t_f$		N-Ch		9	18		
			P-Ch		9	18		
Turn-On Delay Time	$t_{d(on)}$	N-Channel $V_{DD} = 20\text{ V}$ , $R_L = 4\ \Omega$ $I_D \cong 5\text{ A}$ , $V_{GEN} = 4.5\text{ V}$ , $R_g = 1\ \Omega$	N-Ch		16	30		
			P-Ch		49	80		
Rise Time	$t_r$		N-Ch		17	30		
			P-Ch		79	120		
Turn-Off Delay Time	$t_{d(off)}$	P-Channel $V_{DD} = -20\text{ V}$ , $R_L = 4\ \Omega$ $I_D \cong -5\text{ A}$ , $V_{GEN} = -4.5\text{ V}$ , $R_g = 16\ \Omega$	N-Ch		16	30		
			P-Ch		35	60		
Fall Time	$t_f$		N-Ch		10	20		
			P-Ch		14	25		
<b>Drain-Source Body Diode Characteristics</b>								
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25\text{ }^\circ\text{C}$	N-Ch			2.5	A	
			P-Ch			-2.5		
Pulse Diode Forward Current <sup>a</sup>	$I_{SM}$		N-Ch			20		
			P-Ch			-20		
Body Diode Voltage	$V_{SD}$	$I_S = 1.6\text{ A}$	N-Ch		0.78	1.2	V	
		$I_S = -1.6\text{ A}$	P-Ch		-0.74	-1.2		
Body Diode Reverse Recovery Time	$t_{rr}$	N-Channel $I_F = 2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 25\text{ }^\circ\text{C}$	N-Ch		19	30	ns	
			P-Ch		22	40		
Body Diode Reverse Recovery Charge	$Q_{rr}$			N-Ch		14	25	nC
				P-Ch		22	35	
Reverse Recovery Fall Time	$t_a$	P-Channel $I_F = -2\text{ A}$ , $di/dt = -100\text{ A}/\mu\text{s}$ , $T_J = 25\text{ }^\circ\text{C}$	N-Ch		13		ns	
			P-Ch		15			
Reverse Recovery Rise Time	$t_b$			N-Ch		6		
				P-Ch		7		

Notes:

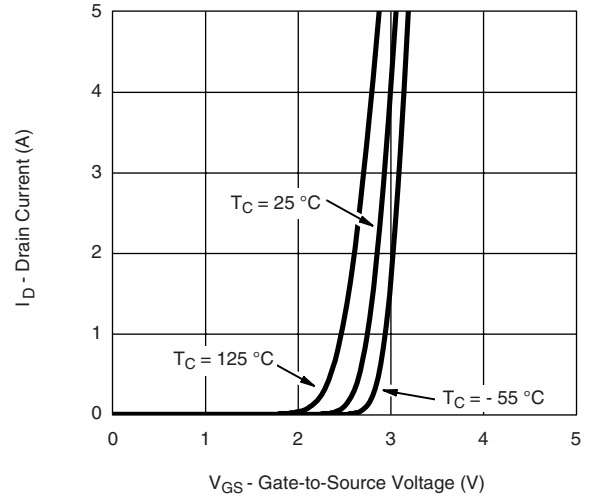
- a. Guaranteed by design, not subject to production testing.
- b. Pulse test; pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\%$ .

*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.*

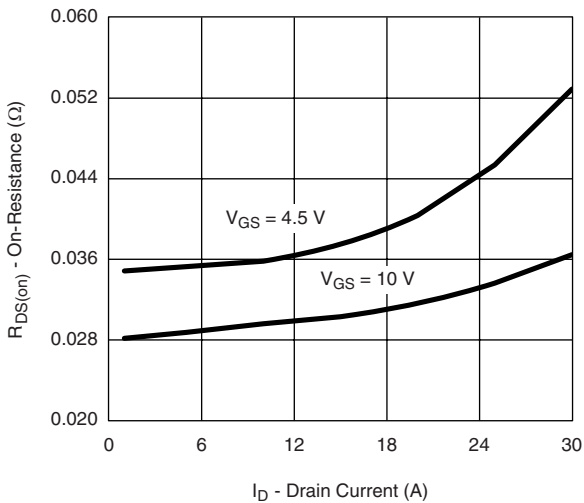
## N-CHANNEL TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



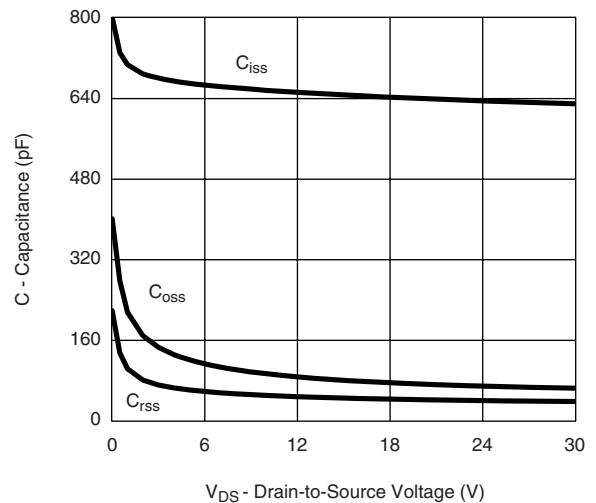
**Output Characteristics**



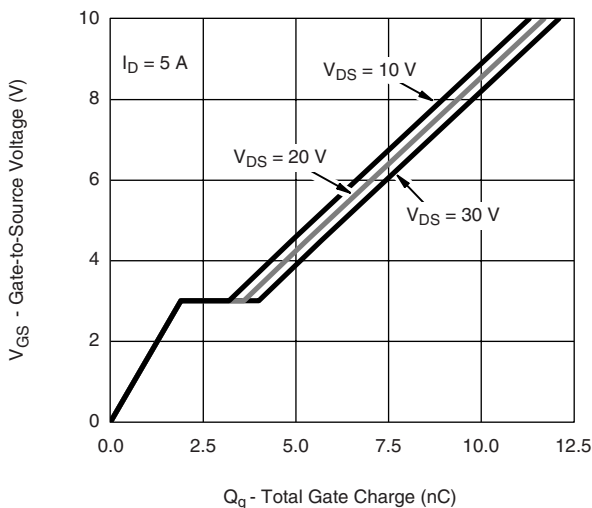
**Transfer Characteristics**



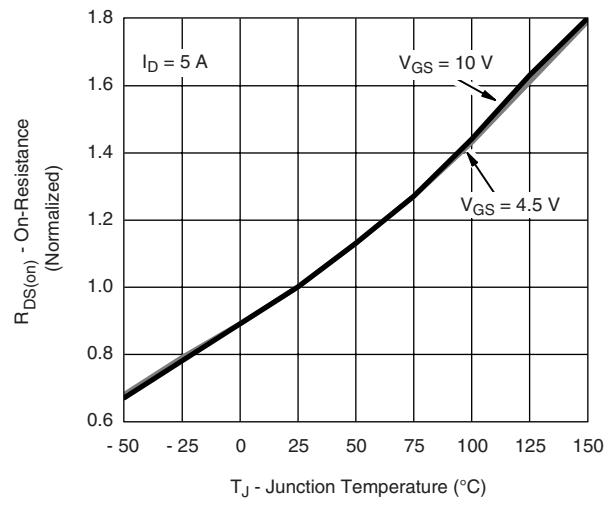
**On-Resistance vs. Drain Current**



**Capacitance**



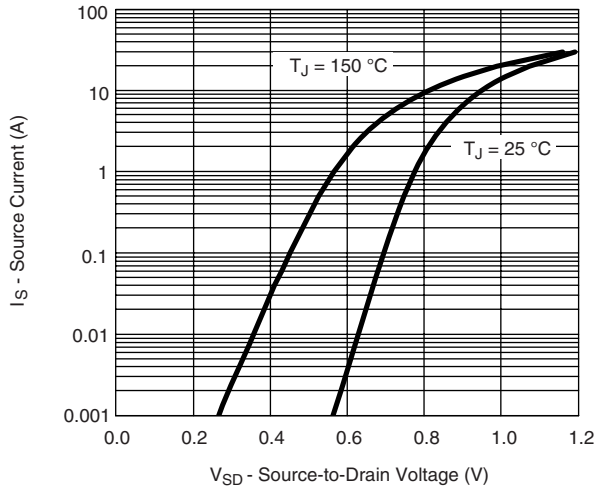
**Gate Charge**



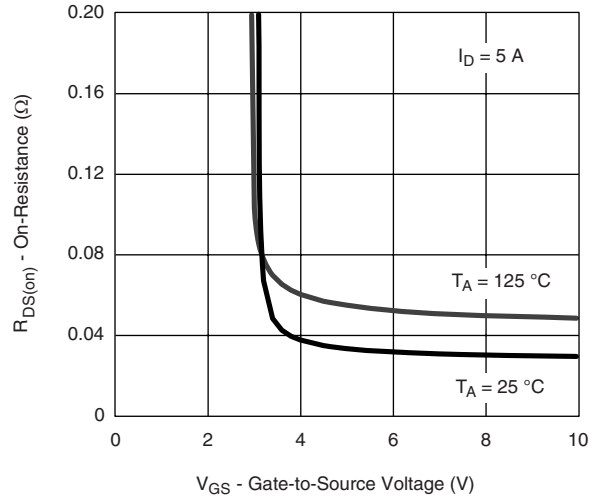
**On-Resistance vs. Junction Temperature**



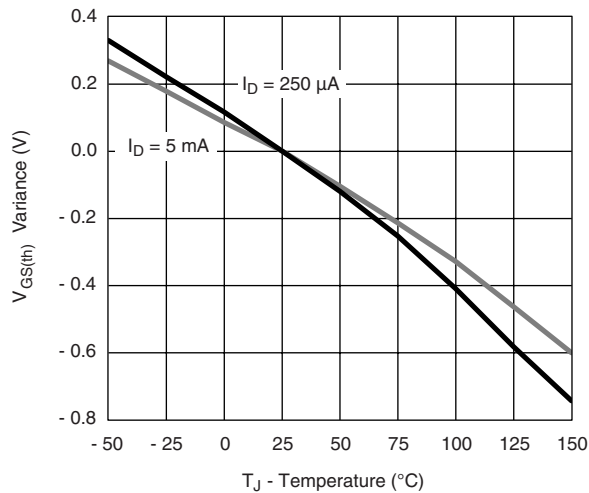
**N-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



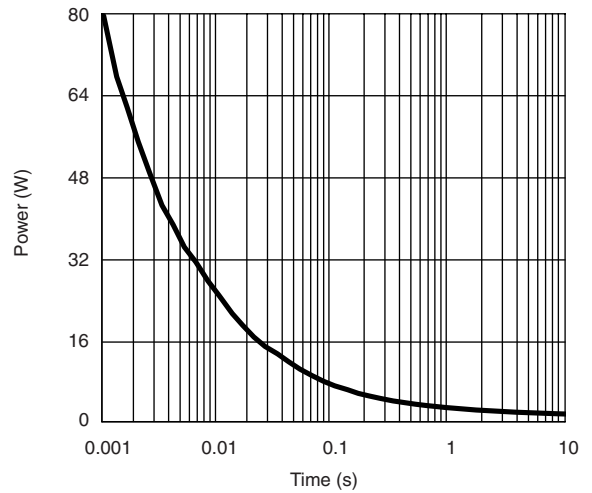
**Source-Drain Diode Forward Voltage**



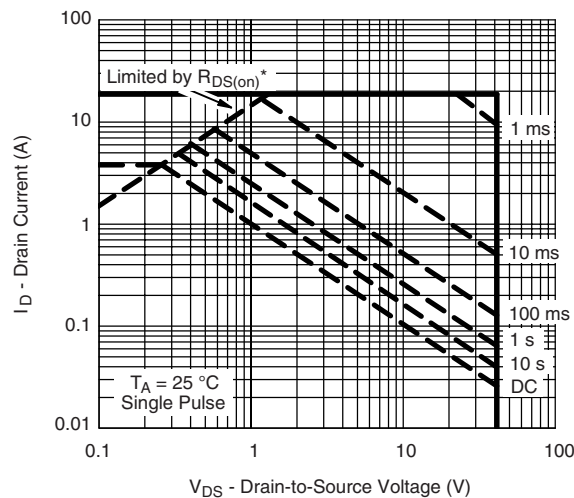
**On-Resistance vs. Gate-to-Source Voltage**



**Threshold Voltage**



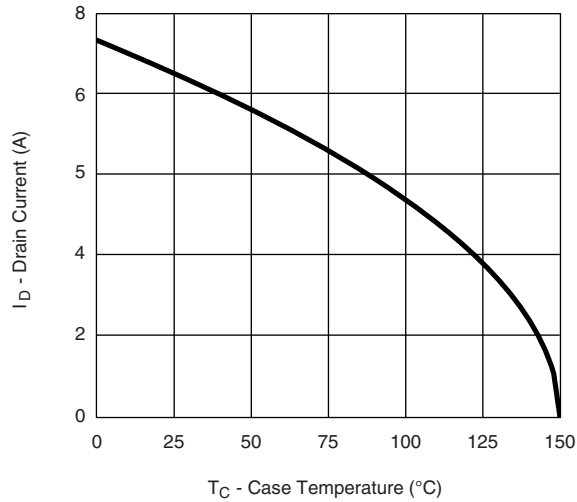
**Single Pulse Power, Junction-to-Ambient**



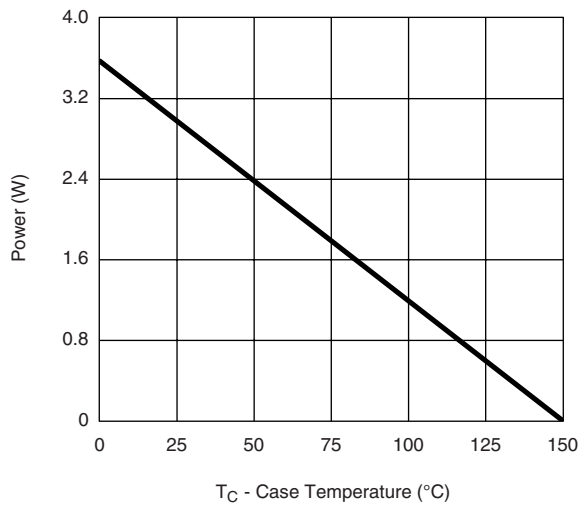
\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

**Safe Operating Area, Junction-to-Ambient**

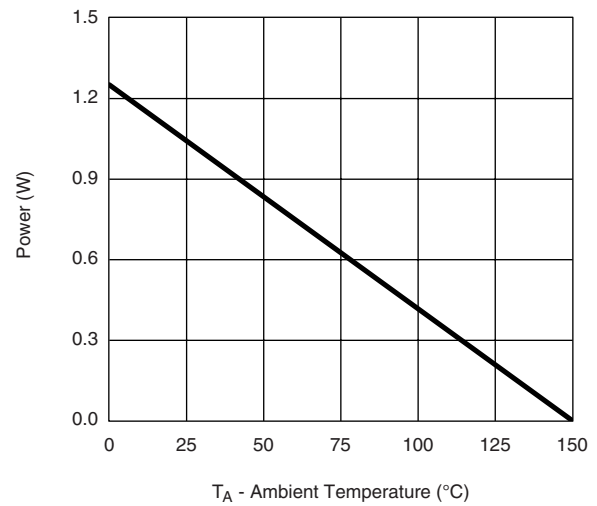
## N-CHANNEL TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



**Current Derating\***



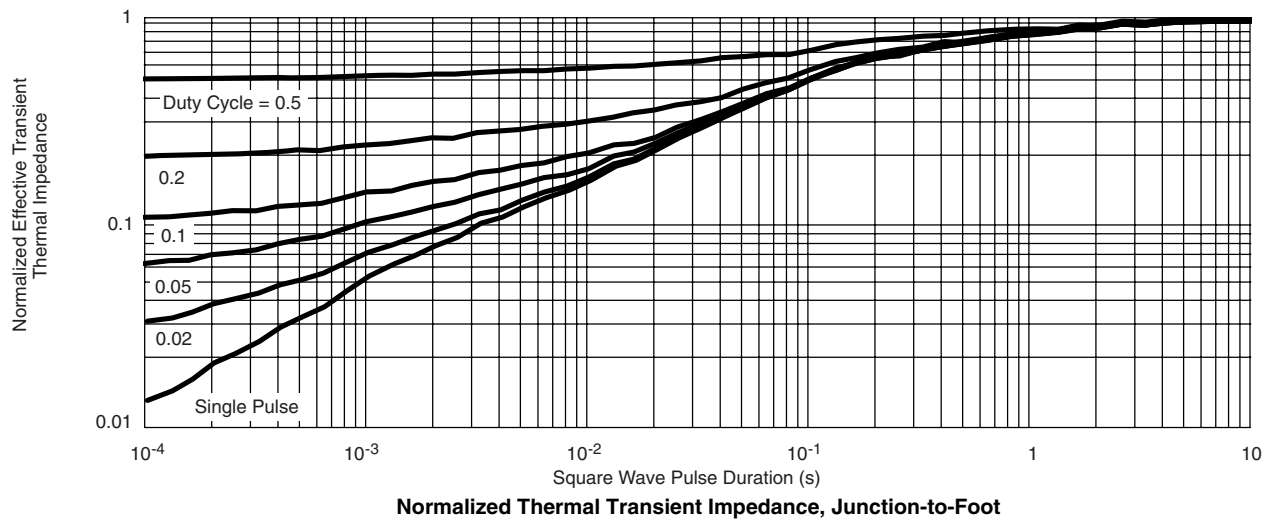
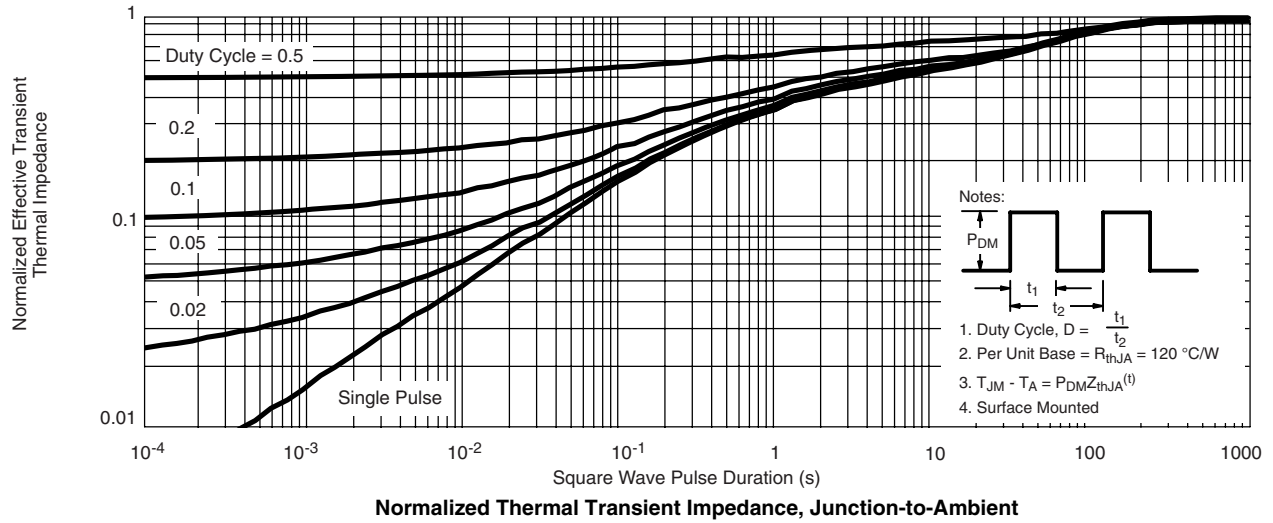
**Power Derating, Junction-to-Foot**



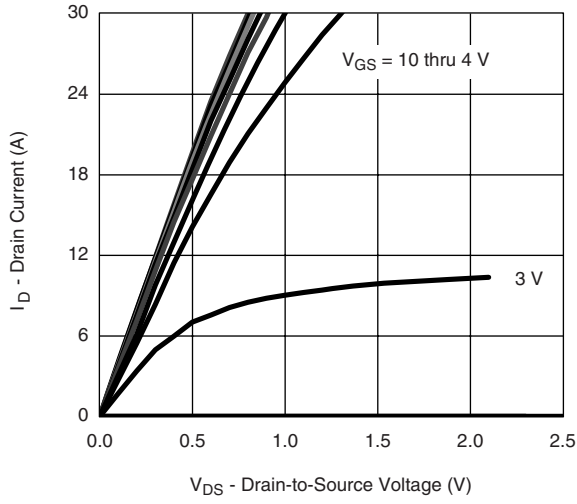
**Power Derating, Junction-to-Ambient**

\* 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.

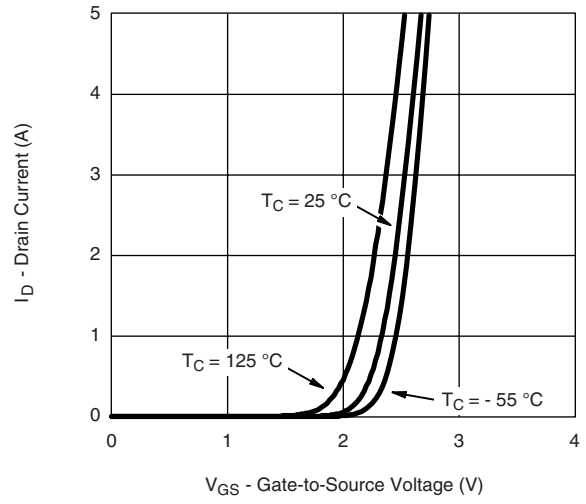
**N-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



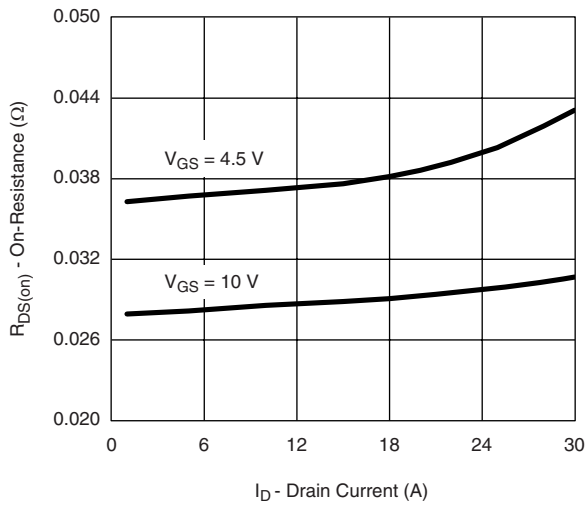
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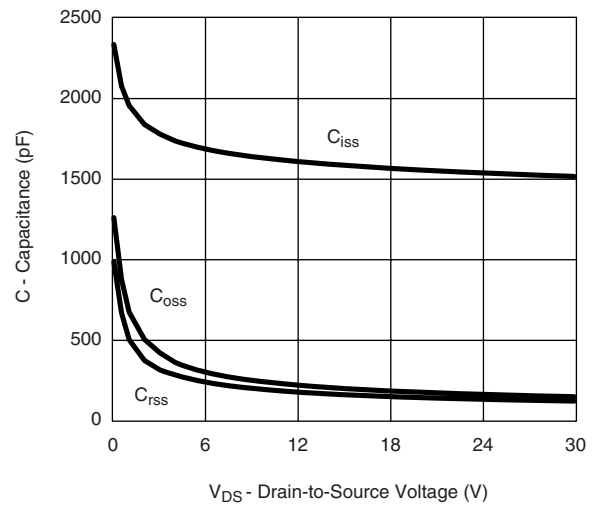
**Output Characteristics**



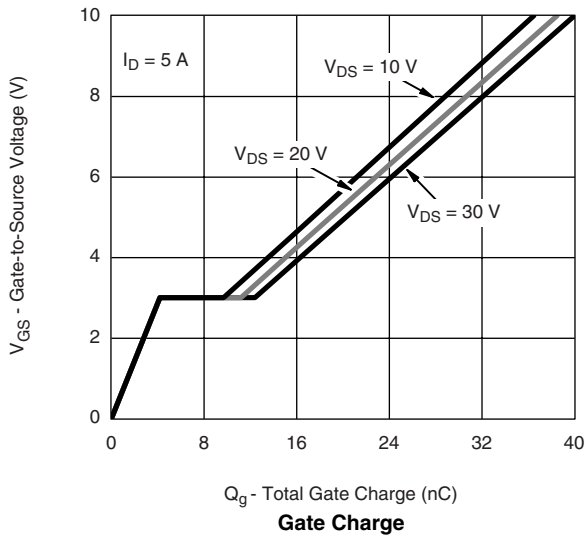
**Transfer Characteristics**



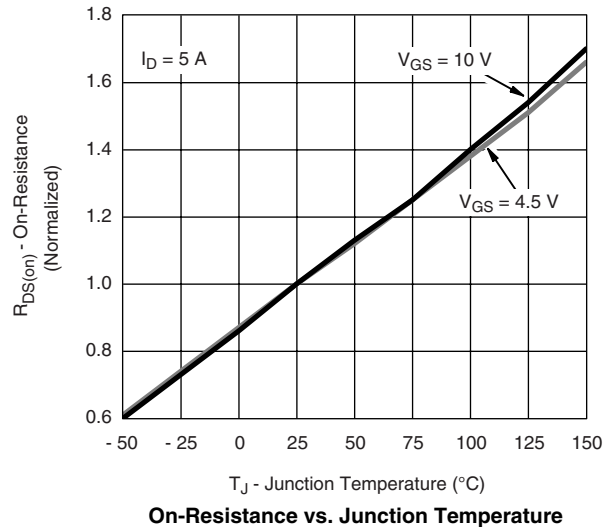
**On-Resistance vs. Drain Current**



**Capacitance**



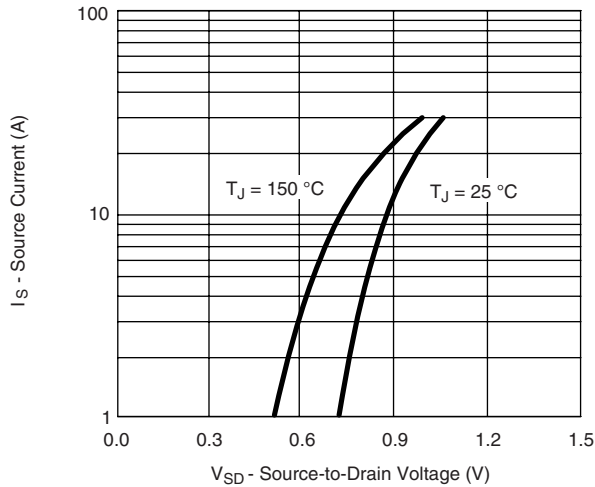
**Gate Charge**



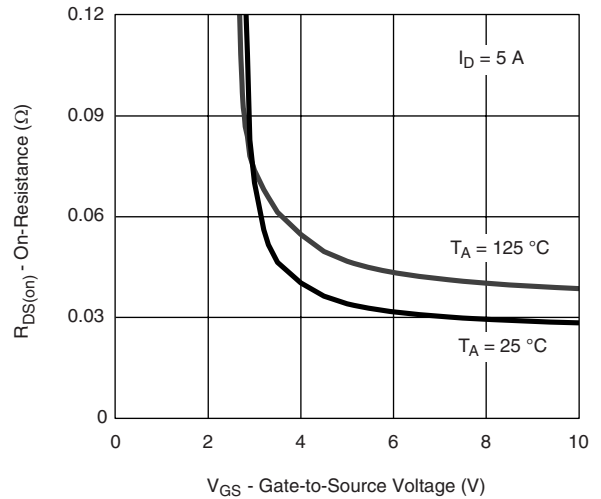
**On-Resistance vs. Junction Temperature**



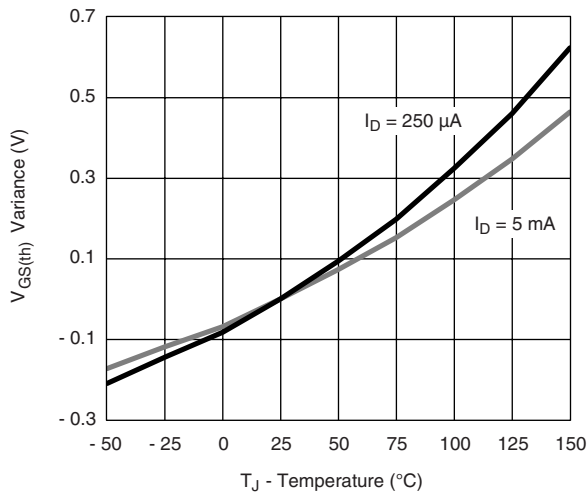
## P-CHANNEL TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



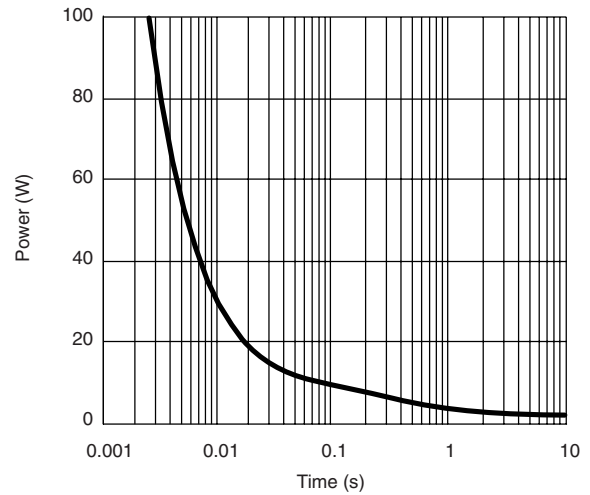
Source-Drain Diode Forward Voltage



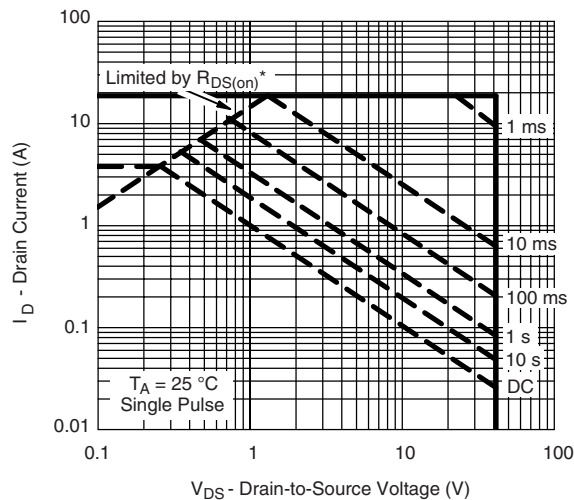
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage



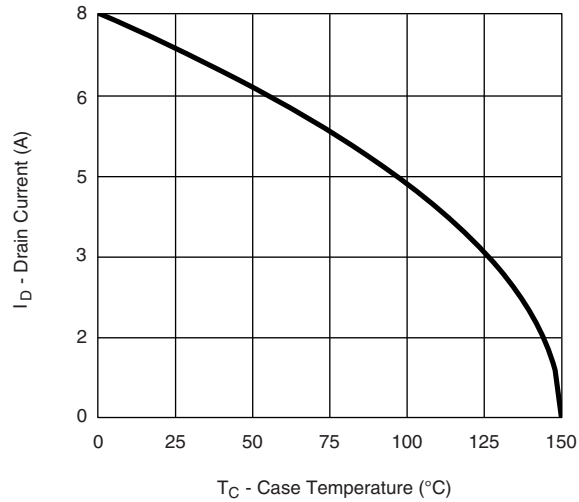
Single Pulse Power, Junction-to-Ambient



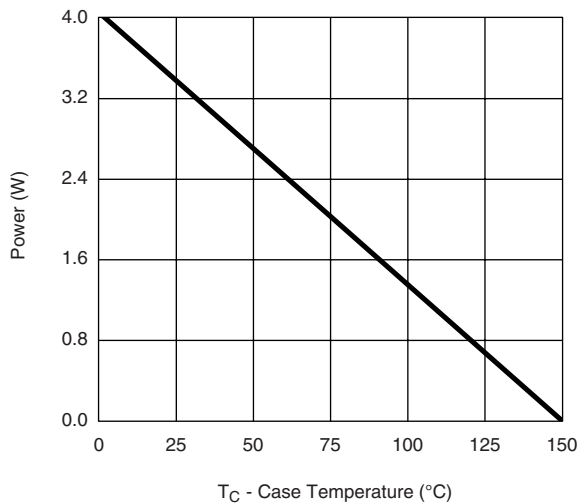
\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

Safe Operating Area, Junction-to-Ambient

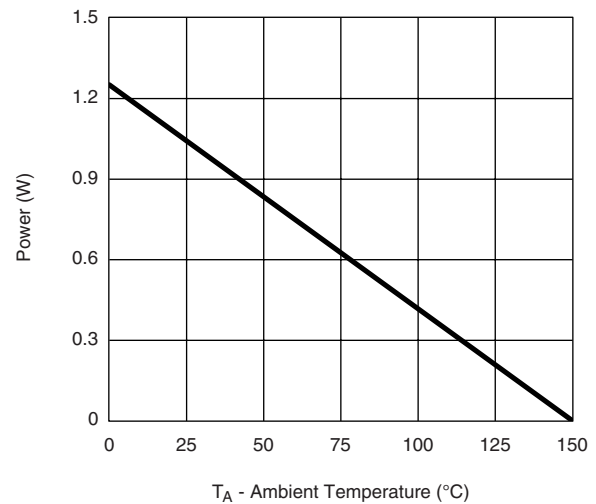
**P-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



**Current Derating\***



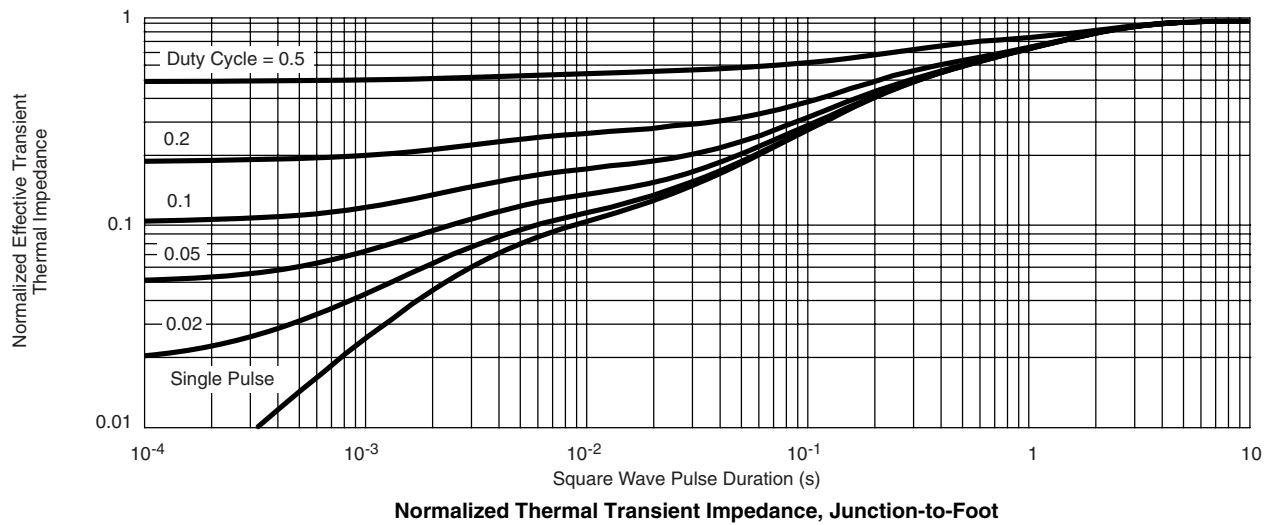
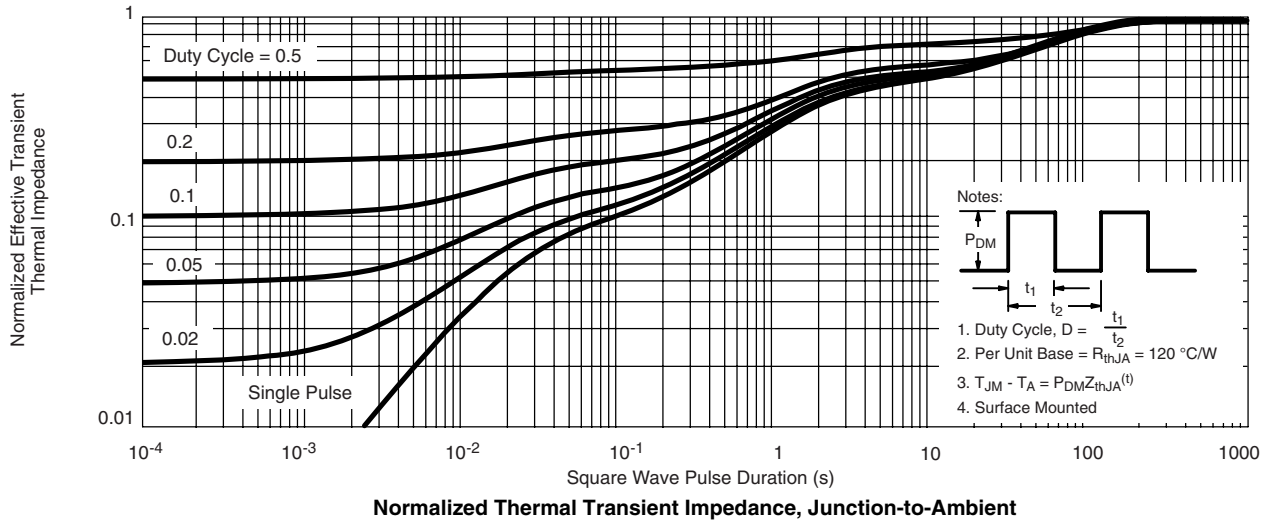
**Power Derating, Junction-to-Foot**



**Power Derating, Junction-to-Ambient**

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**P-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



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