

## N- and P-Channel 60-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	60	0.058 at V <sub>GS</sub> = 10 V	5.3	6 nC
		0.072 at V <sub>GS</sub> = 4.5 V	4.7	
P-Channel	-60	0.120 at V <sub>GS</sub> = -10 V	-3.9	8nC
		0.150 at V <sub>GS</sub> = -4.5 V	-3.5	

### FEATURES

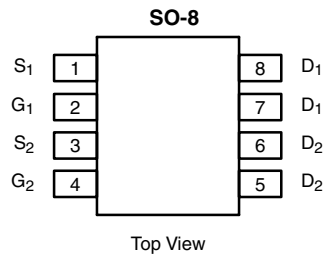
- TrenchFET® Power MOSFET
- 100 % R<sub>g</sub> & UIS Tested

### APPLICATIONS

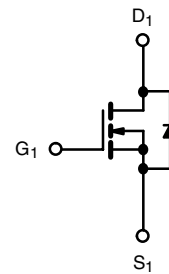
- CCFL Inverter



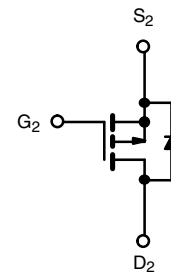
RoHS  
COMPLIANT



Ordering Information: Si4559ADY-T1—E3 (Lead (Pb)-free)



N-Channel MOSFET



P-Channel MOSFET

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>	60	-60	V
Gate-Source Voltage	V <sub>GS</sub>	± 20		
Continuous Drain Current (T <sub>J</sub> = 150 °C)	T <sub>C</sub> = 25 °C	5.3	-3.9	A
	T <sub>C</sub> = 70 °C	4.3	-3.2	
	T <sub>A</sub> = 25 °C	4.3 <sup>b, c</sup>	-3.0 <sup>b, c</sup>	
	T <sub>A</sub> = 70 °C	3.4 <sup>b, c</sup>	-2.4 <sup>b, c</sup>	
Pulsed Drain Current (10 μs Pulse Width)	I <sub>DM</sub>	20	-25	A
Source-Drain Current Diode Current	T <sub>C</sub> = 25 °C	2.6	-2.8	
	T <sub>A</sub> = 25 °C	1.7 <sup>b, c</sup>	-1.7 <sup>b, c</sup>	
Pulsed Source-Drain Current	I <sub>SM</sub>	20	-25	mJ
Single Pulse Avalanche Current	L = 0.1 mH I <sub>AS</sub>	11	15	
Single Pulse Avalanche Energy	E <sub>AS</sub>	6.1	11	W
Maximum Power Dissipation	T <sub>C</sub> = 25 °C	3.1	3.4	
	T <sub>C</sub> = 70 °C	2	2.2	
	T <sub>A</sub> = 25 °C	2 <sup>b, c</sup>	2 <sup>b, c</sup>	
	T <sub>A</sub> = 70 °C	1.3 <sup>b, c</sup>	1.3 <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>	t ≤ 10 sec	R <sub>thJA</sub>	55	62.5	53	62.5	°C/W
Maximum Junction-to-Foot (Drain)	Steady-State	R <sub>thJF</sub>	33	40	30	37	

Notes

- Based on T<sub>C</sub> = 25 °C.
- Surface Mounted on 1" x 1" FR4 Board.
- t = 10 sec.
- Maximum under steady state conditions is 110 °C/W for N-channel and P-channel.

SPECIFICATIONS (T <sub>J</sub> = 25 °C UNLESS OTHERWISE NOTED)							
Parameter	Symbol	Test Condition	Min	Typ <sup>a</sup>	Max	Unit	
<b>Static</b>							
Drain-Source Breakdown Voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA	N-Ch	60		V	
		V <sub>GS</sub> = 0 V, I <sub>D</sub> = -250 μA	P-Ch	-60			
V <sub>DS</sub> Temperature Coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	I <sub>D</sub> = 250 μA	N-Ch		55	mV	
		I <sub>D</sub> = -250 μA	P-Ch		-50		
V <sub>GS(th)</sub> Temperature Coefficient	ΔV <sub>GS(th)</sub> /T <sub>J</sub>	I <sub>D</sub> = 250 μA	N-Ch		-6	mV	
		I <sub>D</sub> = -250 μA	P-Ch		4		
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	N-Ch	1		3	V
		V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA	P-Ch	-1		-3	
Gate-Body Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±20 V	N-Ch			100	nA
			P-Ch			-100	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V	N-Ch			1	μA
			P-Ch			-1	
		V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 55 °C	N-Ch			10	
			P-Ch			-10	
On-State Drain Current <sup>b</sup>	I <sub>D(on)</sub>	V <sub>DS</sub> ≥ 5 V, V <sub>GS</sub> = 10 V	N-Ch	20		A	
		V <sub>DS</sub> ≤ -5 V, V <sub>GS</sub> = -10 V	P-Ch	-25			
Drain-Source On-State Resistance <sup>b</sup>	r <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 4.3 A	N-Ch		0.046	0.058	Ω
			P-Ch		0.1	0.120	
		V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 3.9 A	N-Ch		0.059	0.072	
			P-Ch		0.126	0.150	
Forward Transconductance <sup>b</sup>	g <sub>fs</sub>	V <sub>DS</sub> = 15 V, I <sub>D</sub> = 4.3 A	N-Ch		15	S	
		V <sub>DS</sub> = -15 V, I <sub>D</sub> = -3.1 A	P-Ch		8.5		
<b>Dynamic<sup>a</sup></b>							
Input Capacitance	C <sub>iss</sub>	N-Channel V <sub>DS</sub> = 15 V, V <sub>GS</sub> = 0 V, f = 1 MHz  P-Channel V <sub>DS</sub> = -15 V, V <sub>GS</sub> = 0 V, f = 1 MHz	N-Ch		665	pF	
			P-Ch		650		
Output Capacitance	C <sub>oss</sub>		N-Ch		75		
			P-Ch		95		
Reverse Transfer Capacitance	C <sub>rss</sub>		N-Ch		40		
			P-Ch		60		
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> = 30 V, V <sub>GS</sub> = 10 V, I <sub>D</sub> = 4.3 A	N-Ch		13	20	nC
		V <sub>DS</sub> = -30 V, V <sub>GS</sub> = -10 V, I <sub>D</sub> = -3.1 A	P-Ch		14.5	22	
	N-Channel V <sub>DS</sub> = 30 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 4.3 A	N-Ch		6	9		
		P-Ch		8	12		
Gate-Source Charge	Q <sub>gs</sub>	P-Channel V <sub>DS</sub> = -30 V, V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -3.1 A	N-Ch		2.3		
			P-Ch		2.2		
Gate-Drain Charge	Q <sub>gd</sub>	N-Ch		2.6			
		P-Ch		3.7			
Gate Resistance	R <sub>g</sub>	f = 1 MHz	N-Ch		2	3	Ω
			P-Ch		14	20	



SPECIFICATIONS (T <sub>J</sub> = 25 °C UNLESS OTHERWISE NOTED)							
Parameter	Symbol	Test Condition	Min	Typ <sup>a</sup>	Max	Unit	
<b>Dynamic<sup>a</sup></b>							
Turn-On Delay Time	t <sub>d(on)</sub>	N-Channel V <sub>DD</sub> = 30 V, R <sub>L</sub> = 8.8 Ω I <sub>D</sub> ≅ 3.4 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	15	25		ns
			P-Ch	30	45		
Rise Time	t <sub>r</sub>	P-Channel V <sub>DD</sub> = -30 V, R <sub>L</sub> = 12.5 Ω I <sub>D</sub> ≅ -2.4 A, V <sub>GEN</sub> = -4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	65	100		
			P-Ch	70	105		
Turn-Off Delay Time	t <sub>d(off)</sub>	N-Channel V <sub>DD</sub> = 30 V, R <sub>L</sub> = 8.8 Ω I <sub>D</sub> ≅ 3.4 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω	N-Ch	15	25		
			P-Ch	40	60		
Fall Time	t <sub>f</sub>	P-Channel V <sub>DD</sub> = -30 V, R <sub>L</sub> = 12.5 Ω I <sub>D</sub> ≅ -2.4 A, V <sub>GEN</sub> = -10 V, R <sub>g</sub> = 1 Ω	N-Ch	10	15		
			P-Ch	30	45		
Turn-On Delay Time	t <sub>d(on)</sub>	N-Channel V <sub>DD</sub> = 30 V, R <sub>L</sub> = 8.8 Ω I <sub>D</sub> ≅ 3.4 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω	N-Ch	10	15		
			P-Ch	10	15		
Rise Time	t <sub>r</sub>	P-Channel V <sub>DD</sub> = -30 V, R <sub>L</sub> = 12.5 Ω I <sub>D</sub> ≅ -2.4 A, V <sub>GEN</sub> = -10 V, R <sub>g</sub> = 1 Ω	N-Ch	15	25		
			P-Ch	13	20		
Turn-Off Delay Time	t <sub>d(off)</sub>	N-Channel V <sub>DD</sub> = 30 V, R <sub>L</sub> = 8.8 Ω I <sub>D</sub> ≅ 3.4 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω	N-Ch	20	30		
			P-Ch	35	55		
Fall Time	t <sub>f</sub>	P-Channel V <sub>DD</sub> = -30 V, R <sub>L</sub> = 12.5 Ω I <sub>D</sub> ≅ -2.4 A, V <sub>GEN</sub> = -10 V, R <sub>g</sub> = 1 Ω	N-Ch	10	15		
			P-Ch	30	45		
<b>Drain-Source Body Diode Characteristics</b>							
Continuous Source-Drain Diode Current	I <sub>S</sub>	T <sub>C</sub> = 25 °C	N-Ch		2.6		A
			P-Ch		-2.8		
Pulse Diode Forward Current <sup>a</sup>	I <sub>SM</sub>		N-Ch		20		
			P-Ch		-25		
Body Diode Voltage	V <sub>SD</sub>	I <sub>S</sub> = 1.7 A	N-Ch	0.8	1.2		V
		I <sub>S</sub> = -2 A	P-Ch	-0.8	-1.2		
Body Diode Reverse Recovery Time	t <sub>rr</sub>	N-Channel I <sub>F</sub> = 1.7 A, di/dt = 100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	30	60		ns
			P-Ch	30	50		
Body Diode Reverse Recovery Charge	Q <sub>rr</sub>	P-Channel I <sub>F</sub> = -2 A, di/dt = -100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	32	50		nC
			P-Ch	35	60		
Reverse Recovery Fall Time	t <sub>a</sub>	N-Channel I <sub>F</sub> = 1.7 A, di/dt = 100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	25			ns
			P-Ch	16			
Reverse Recovery Rise Time	t <sub>b</sub>	P-Channel I <sub>F</sub> = -2 A, di/dt = -100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	5			
			P-Ch	14			

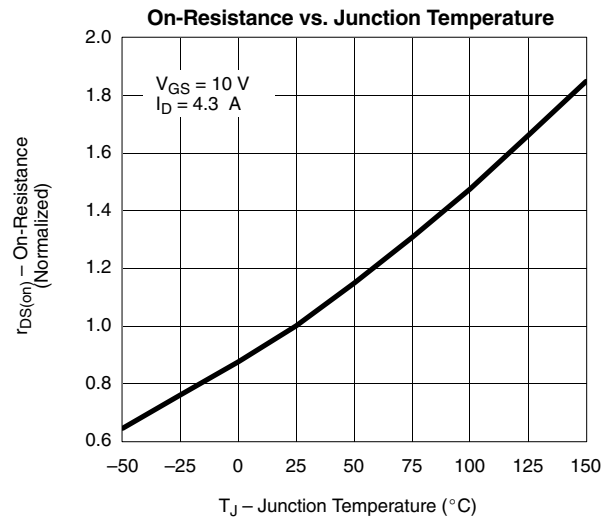
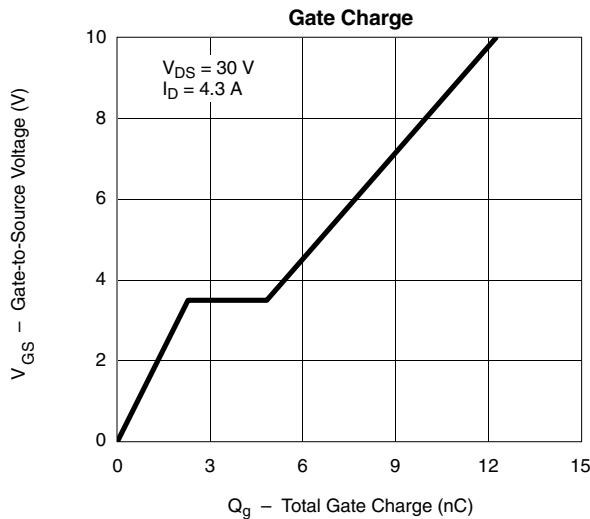
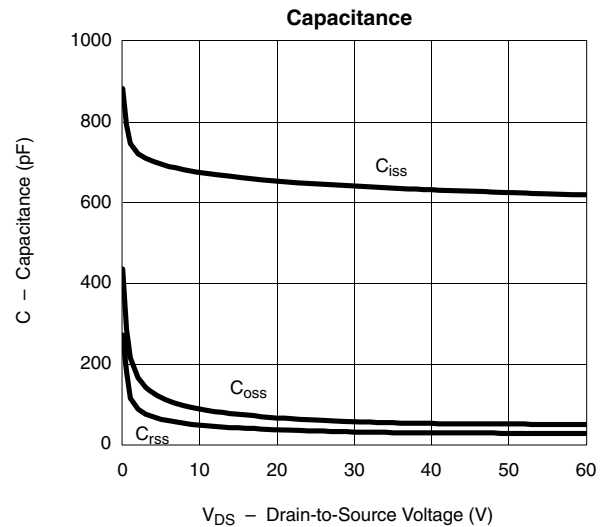
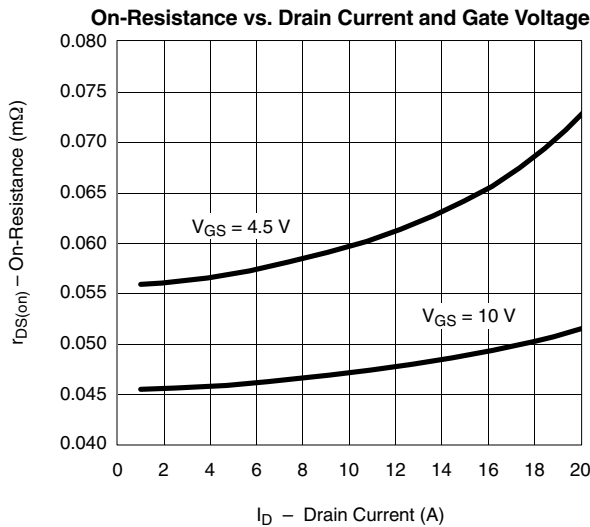
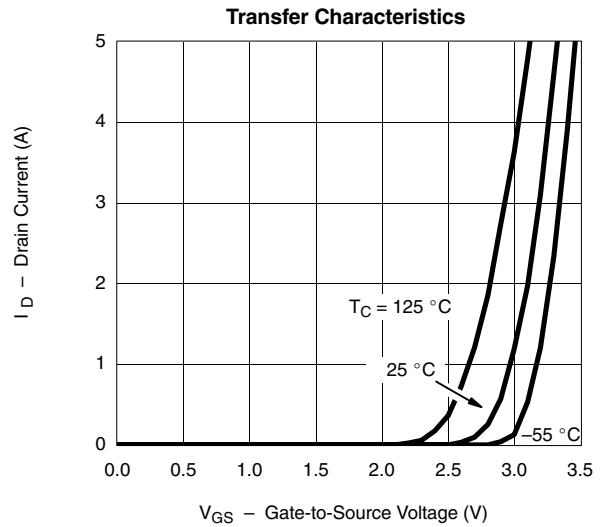
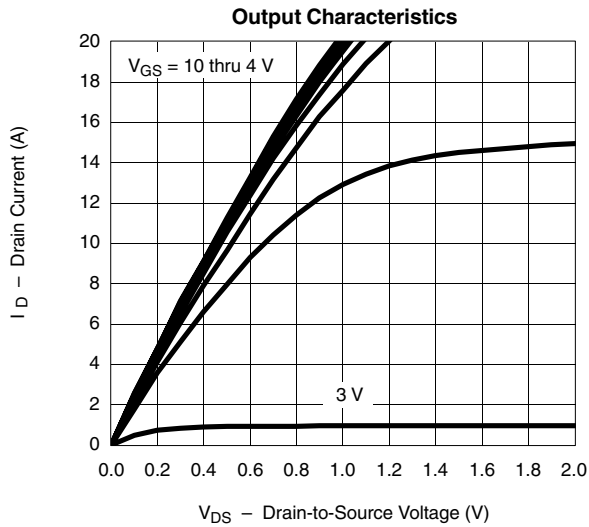
Notes

- a. Guaranteed by design, not subject to production testing.
- b. Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 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.

TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)

N-CHANNEL

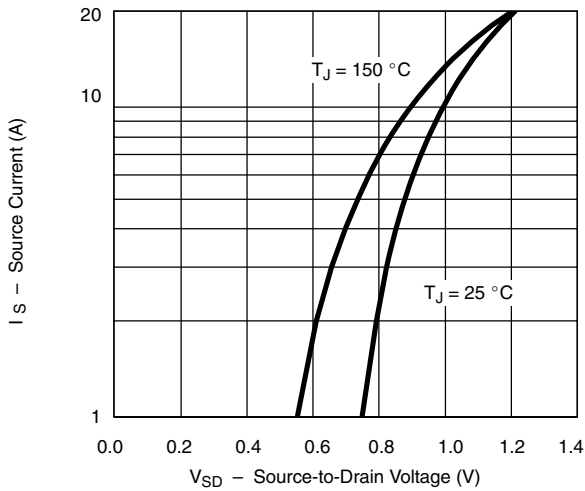




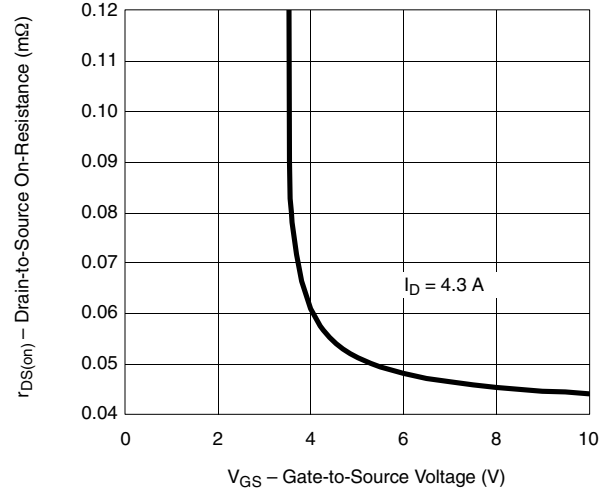
TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)

N-CHANNEL

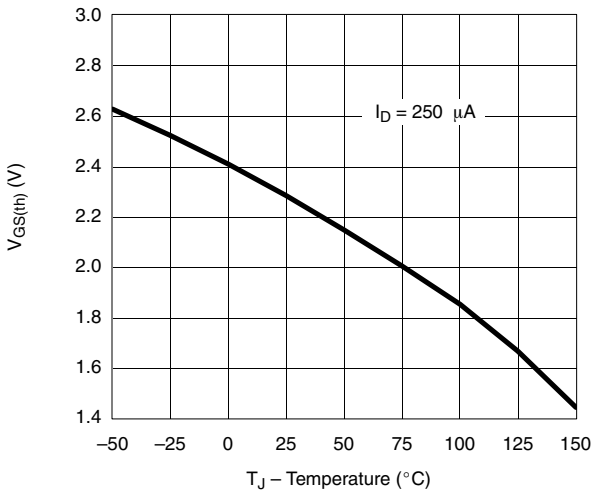
Source-Drain Diode Forward Voltage



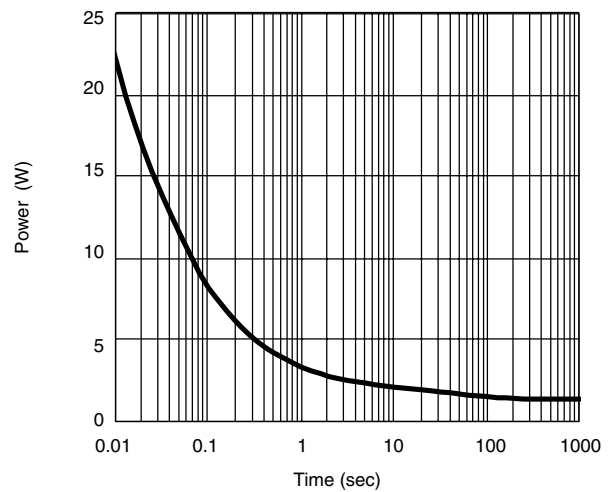
On-Resistance vs. Gate-to-Source Voltage



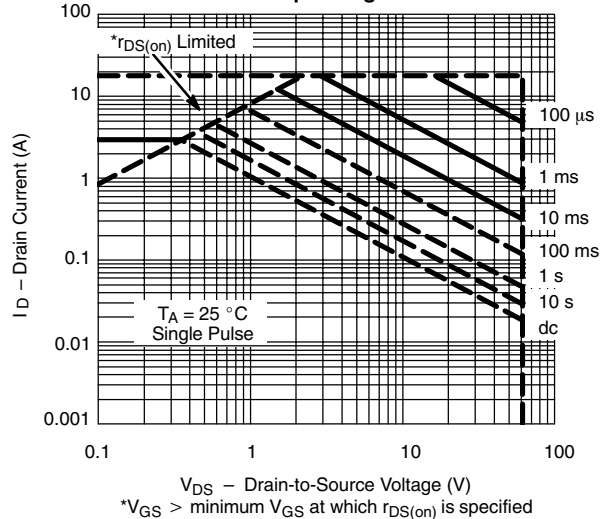
Threshold Voltage



Single Pulse Power, Junction-to-Ambient

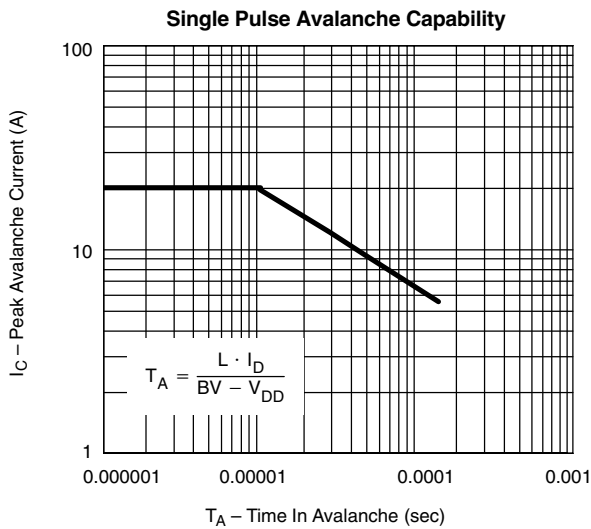
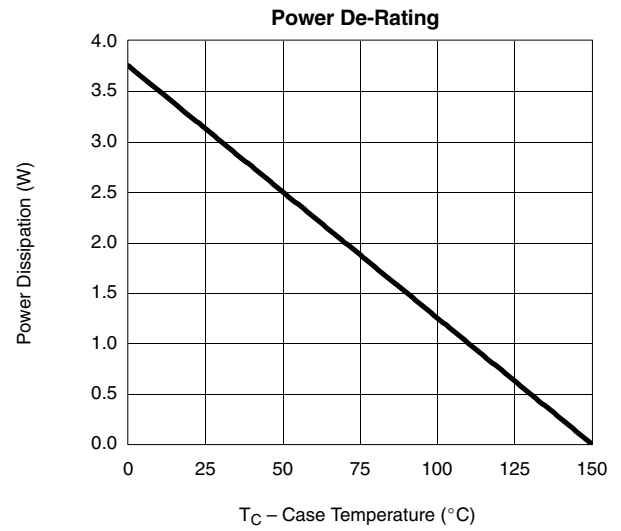
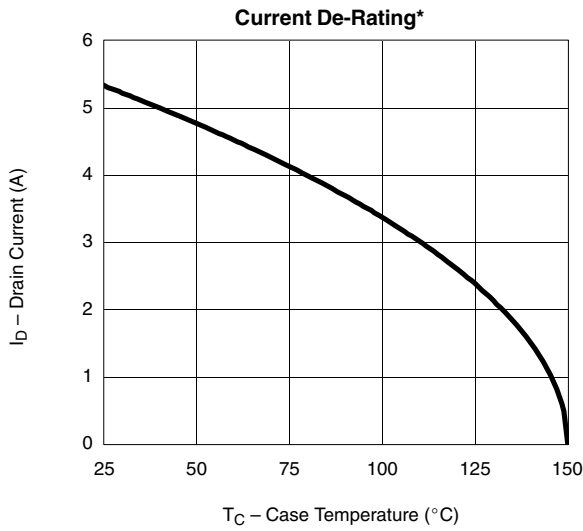


Safe Operating Area



**TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)**

**N-CHANNEL**

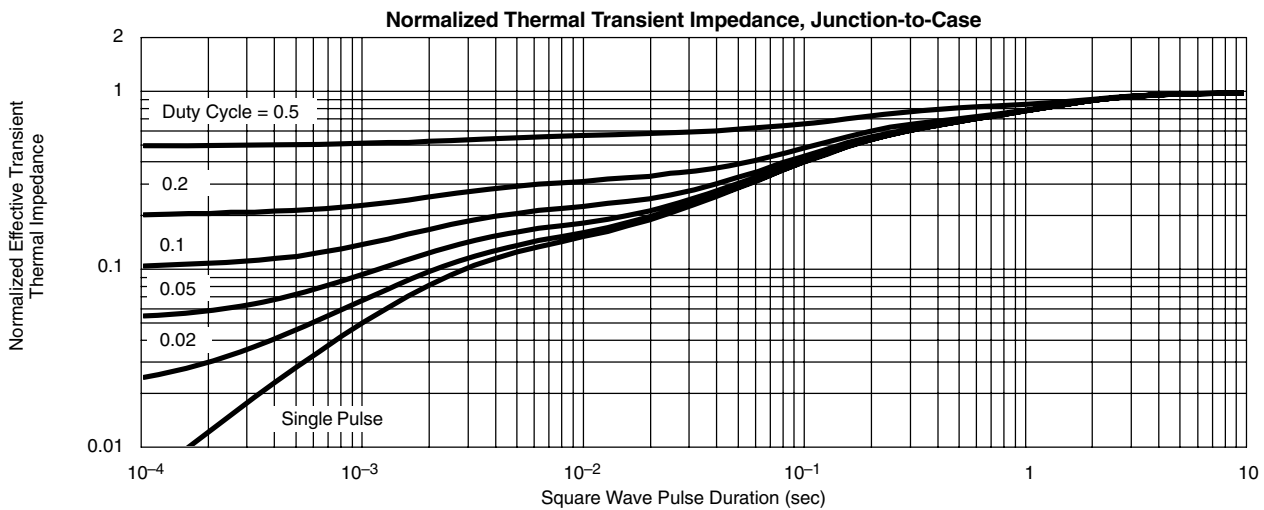
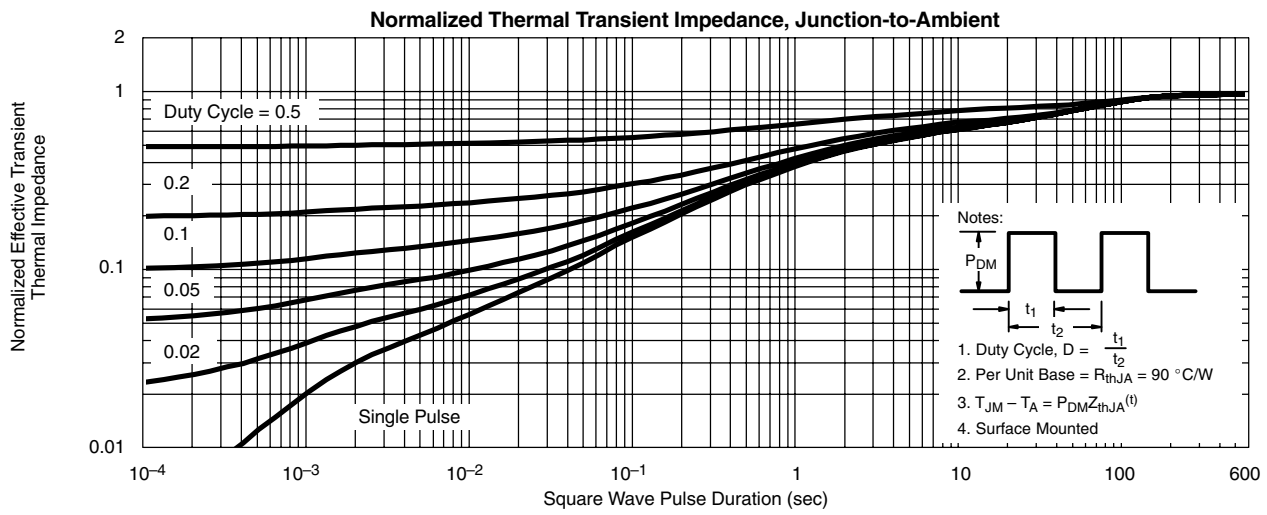


\*The power dissipation  $P_D$  is based on  $T_{J(max)} = 150\text{ °C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the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



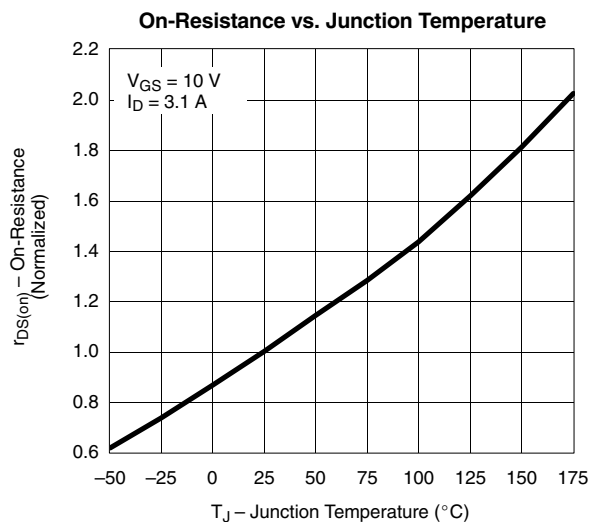
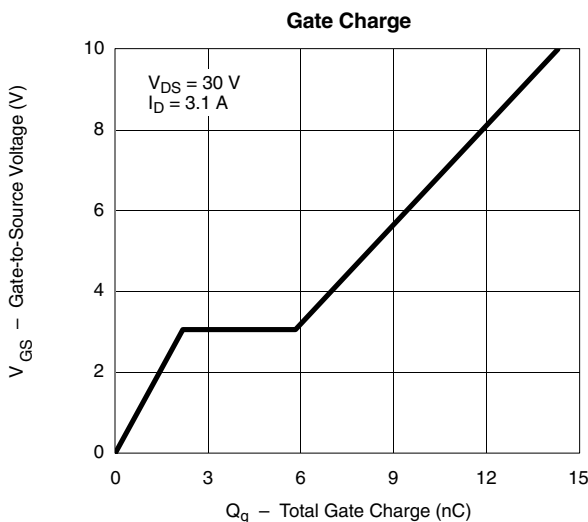
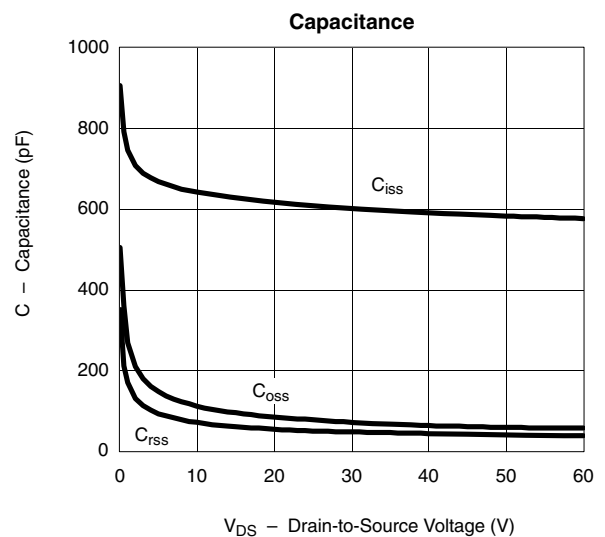
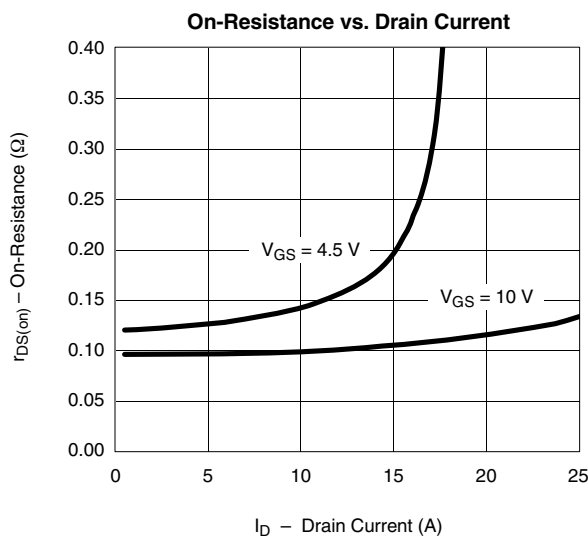
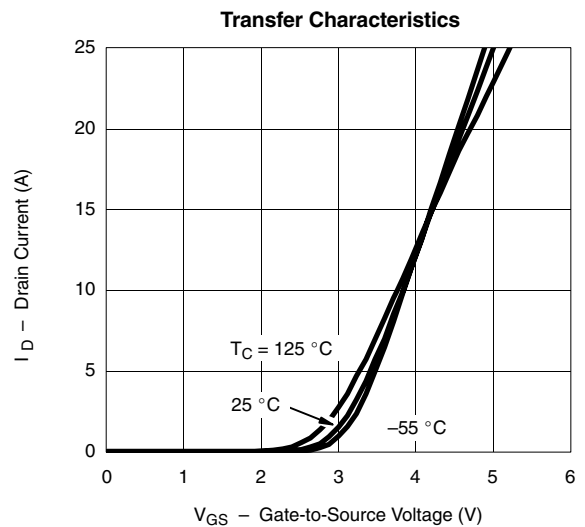
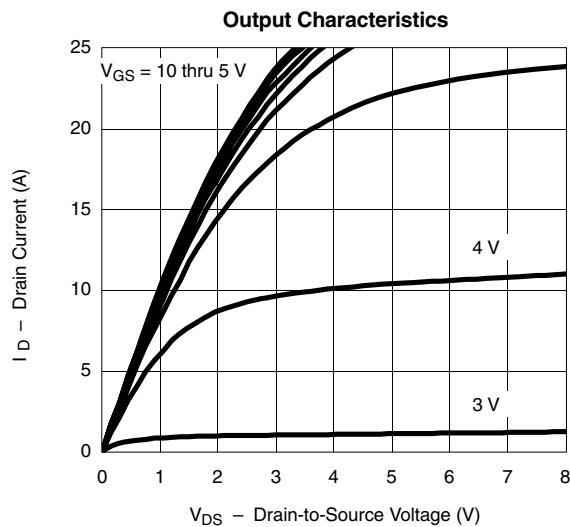
TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)

N-CHANNEL



**TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)**

**P-CHANNEL**



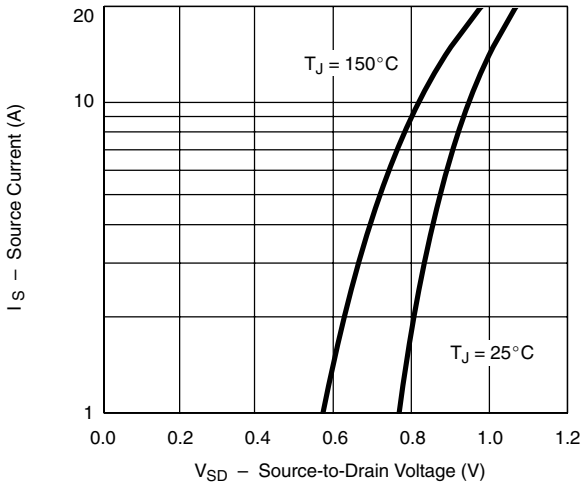




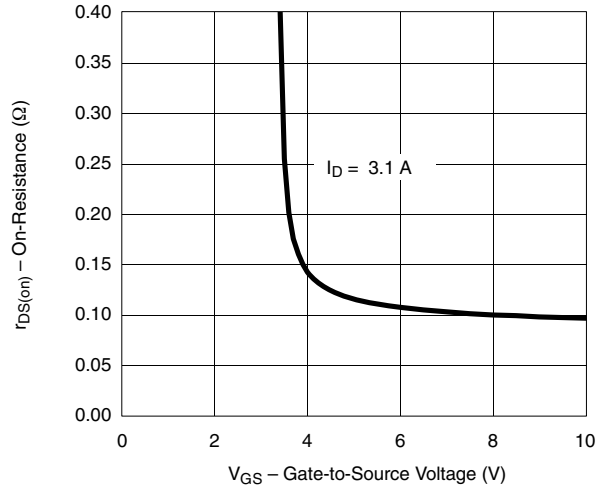
**TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)**

**P-CHANNEL**

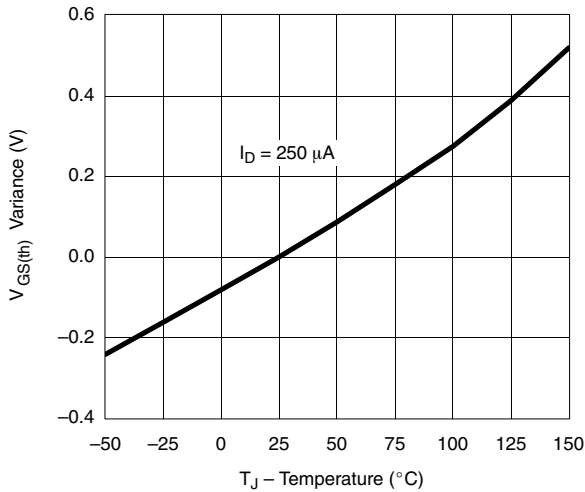
Source-Drain Diode Forward Voltage



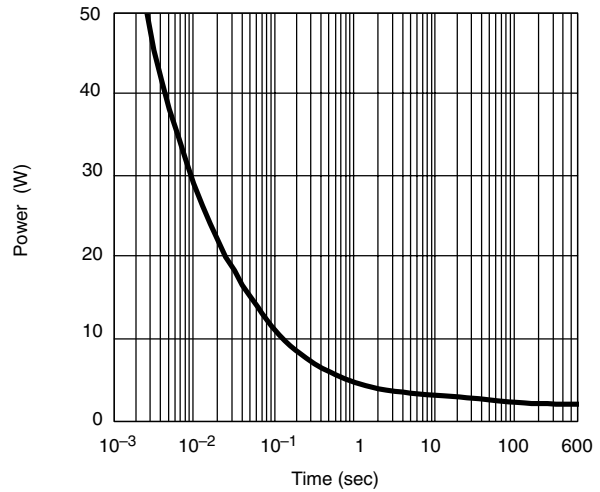
On-Resistance vs. Gate-to-Source Voltage



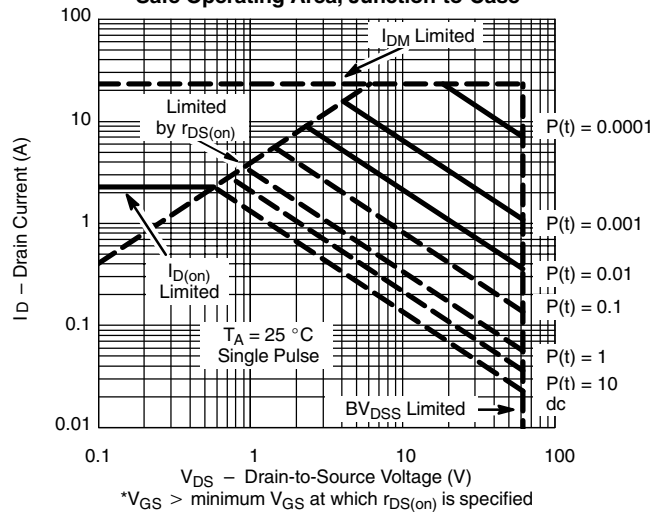
Threshold Voltage



Single Pulse Power

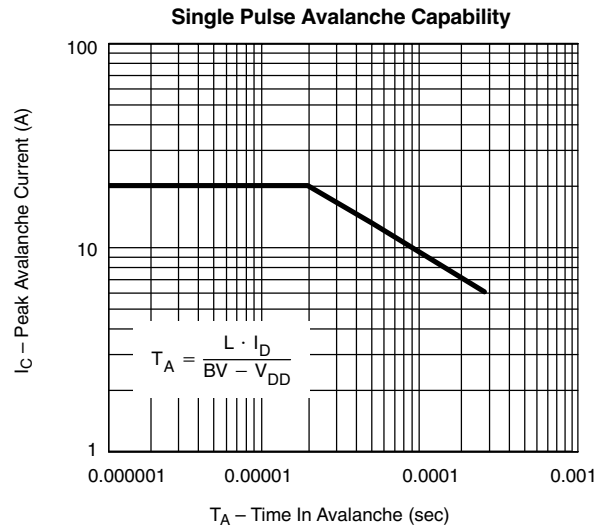
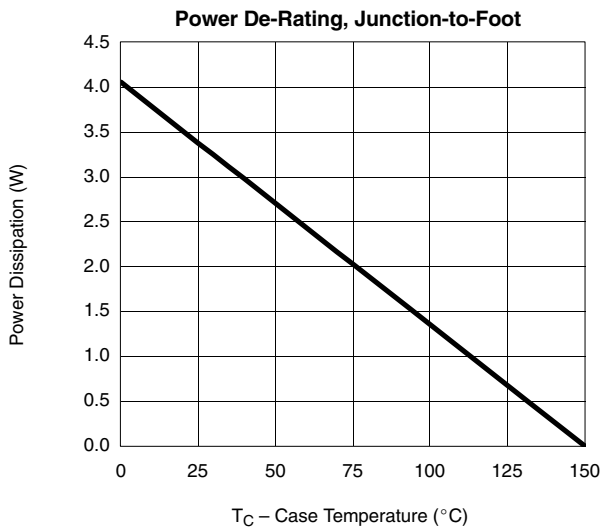
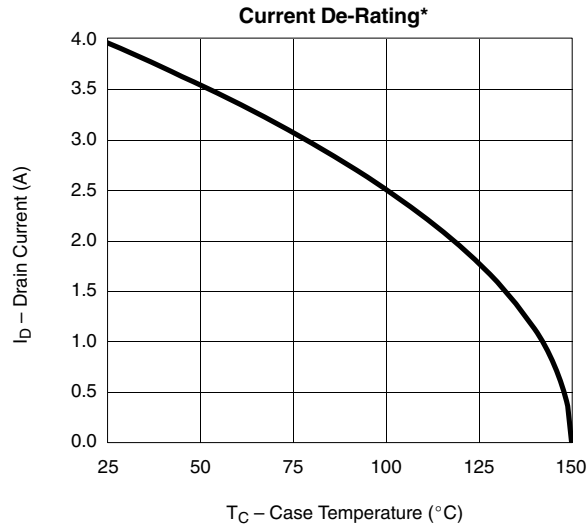


Safe Operating Area, Junction-to-Case



TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)

P-CHANNEL



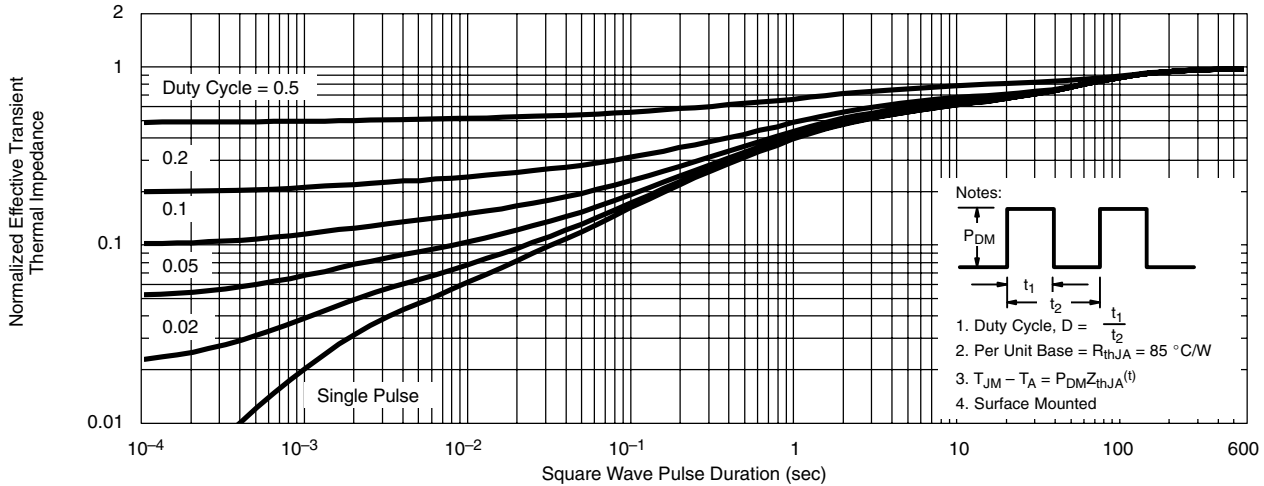
\*The power dissipation  $P_b$  is based on  $T_{J(max)} = 150\text{ }^\circ\text{C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls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



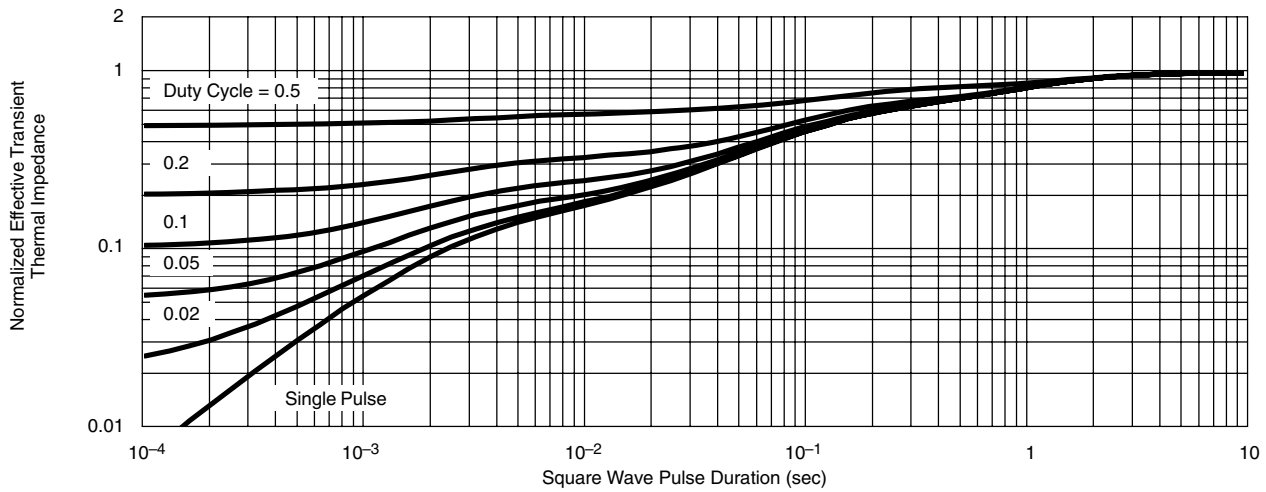
TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)

P-CHANNEL

Normalized Thermal Transient Impedance, Junction-to-Ambient



Normalized Thermal Transient Impedance, Junction-to-Foot



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