ALPHA & OMEGA SEMICONDUCTOR, INC.

Nov 2003

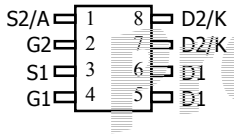
AO4610
Complementary Enhancement Mode Field Effect Transistor

General Description

The AO4610 uses advanced trench technology MOSFETs to provide excellen $R_{DS(ON)}$ and low gate charge. The complementary MOSFETs may be used in inverter and other applications. A Schottky diode is co-packaged with the n-channel FET to minimize body diode losses.

Features

n-channel	p-channel
V_{DS} (V) = 30V	-30V
I_D = 8.5A	-7.1A
$R_{DS(ON)}$	$R_{DS(ON)}$
< 18mΩ (V_{GS}=10V)	< 25mΩ (V_{GS} = 10V)
< 28mΩ (V_{GS}=4.5V)	< 40mΩ (V_{GS} = 4.5V)
V_F<0.5V@1A	



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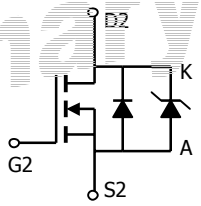
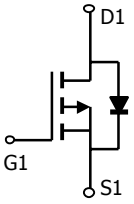


n-channel



p-channel

Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	Max n-channel	Max p-channel	Units
Drain-Source Voltage		V_{DS}	30	-30	V
Gate-Source Voltage		V_{GS}	±20	±20	V
Continuous Drain Current [A]	T_A=25°C	I_D	8.5	-7.1	A
	T_A=70°C		6.6	-5.6	
Pulsed Drain Current [B]		I_{DM}	30	-30	
Power Dissipation	T_A=25°C	P_D	2	2	W
	T_A=70°C		1.28	1.28	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	-55 to 150	°C

Parameter		Symbol	Maximum Schottky	Units
Reverse Voltage		V_{DS}	30	V
Continuous Forward Current [A]	T_A=25°C	I_D	3	A
	T_A=70°C		2	
Pulsed Forward Current [B]		I_{DM}	20	
Power Dissipation [A]	T_A=25°C	P_D	2	W
	T_A=70°C		1.28	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	°C

Thermal Characteristics: n-channel, Schottky and p-channel						
Parameter		**Symbol**	**Device**	**Typ**	**Max**	**Units**
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	n-ch	48	62.5	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		n-ch	74	110	°C/W
Maximum Junction-to-Lead [C]	Steady-State	$R_{\theta JL}$	n-ch	35	60	°C/W
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	p-ch	48	62.5	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		p-ch	74	110	°C/W
Maximum Junction-to-Lead [C]	Steady-State	$R_{\theta JL}$	p-ch	35	40	°C/W
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	Schottky	47.5	62.5	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		Schottky	71	110	°C/W
Maximum Junction-to-Lead [C]	Steady-State	$R_{\theta JL}$	Schottky	32	40	°C/W

N-Channel + Schottky Electrical Characteristics (T_J=25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
STATIC PARAMETERS						
BV_{DSS}	Drain-Source Breakdown Voltage	I_D=250µA, V_{GS}=0V	30			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS}=24V, V_{GS}=0V			25	µA
		T_J=55°C				
I_{GSS}	Gate-Body leakage current	V_{DS}=0V, V_{GS}=±20V			100	nA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS} I_D=250µA	1	1.8	3	V
$I_{D(ON)}$	On state drain current	V_{GS}=4.5V, V_{DS}=5V	40			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS}=10V, I_D=8.5A		15.5	18	mΩ
		T_J=125°C		22.3	27	
		V_{GS}=4.5V, I_D=6.6A		23	28	mΩ
g_{FS}	Forward Transconductance	V_{DS}=5V, I_D=8.5A	10	23		S
V_{SD}	Body-Diode+Schottky Forward Voltage	I_S=1A		0.75	1	V
I_S	Maximum Body-Diode+Schottky Continuous Current				5.5	A
DYNAMIC PARAMETERS						
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=15V, f=1MHz		1040		pF
C_{oss}	Output Capacitance (FET+Schottky)			180		pF
C_{rss}	Reverse Transfer Capacitance			110		pF
R_g	Gate resistance	V_{GS}=0V, V_{DS}=0V, f=1MHz		0.7		Ω
SWITCHING PARAMETERS						
Q_g(10V)	Total Gate Charge	V_{GS}=10V, V_{DS}=15V, I_D=8.5A		19.2		nC
Q_g(4.5V)	Total Gate Charge			9.36		nC
Q_{gs}	Gate Source Charge			2.6		nC
Q_{gd}	Gate Drain Charge			4.2		nC
$t_{D(on)}$	Turn-On DelayTime	V_{GS}=10V, V_{DS}=15V, R_L=1.8Ω, R_{GEN}=3Ω		5.2		ns
t_r	Turn-On Rise Time			4.4		ns
$t_{D(off)}$	Turn-Off DelayTime			17.3		ns
t_f	Turn-Off Fall Time			3.3		ns
t_{rr}	Body-Diode+Schottky Reverse Recovery Time	I_F=8.5A, dI/dt=100A/µs		16.7		ns
Q_{rr}	Body-Diode+Schottky Reverse Recovery Charge	I_F=8.5A, dI/dt=100A/µs		6.7		nC
SCHOTTKY PARAMETERS						
V_F	Forward Voltage Drop	I_F=1.0A		0.45	0.5	V
I_{rm}	Maximum reverse leakage current	V_R=30V		0.007	0.05	mA
		V_R=30V, T_J=125°C		3.2	10	
		V_R=30V, T_J=150°C		12	20	
C_T	Junction Capacitance	V_R=15V		37		pF

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1in ^{2} FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The value in any a given application depends on the user's specific board design. The current rating is based on the t ≤ 10s thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C. The $R_{\theta JA}$ is the sum of the thermal impedence from junction to lead $R_{\theta JL}$ and lead to ambient.

D. The static characteristics in Figures 1 to 6 are obtained using 80 µs pulses, duty cycle 0.5% max.

E. These tests are performed with the device mounted on 1 in ^{2} FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The SOA curve provides a single pulse rating.

P-Channel Electrical Characteristics (T_J=25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
STATIC PARAMETERS						
BV_{DSS}	Drain-Source Breakdown Voltage	I_D=-250µA, V_{GS}=0V	-30			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS}=-24V, V_{GS}=0V			-1	µA
		T_J=55°C			-5	
I_{GSS}	Gate-Body leakage current	V_{DS}=0V, V_{GS}=±20V			±100	nA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS} I_D=-250µA	-1.4	-2	-2.7	V
$I_{D(ON)}$	On state drain current	V_{GS}=-10V, V_{DS}=-5V	30			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS}=-10V, I_D=-7.1A		20	25	mΩ
		T_J=125°C		27	33	
		V_{GS}=-4.5V, I_D=-5.6A		29	40	mΩ
g_{FS}	Forward Transconductance	V_{DS}=-5V, I_D=-7.1A		19.6		S
V_{SD}	Diode Forward Voltage	I_S=-1A,V_{GS}=0V		-0.7	-1	V
I_S	Maximum Body-Diode Continuous Current				-4.2	A
DYNAMIC PARAMETERS						
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=-15V, f=1MHz		1573		pF
C_{oss}	Output Capacitance			319		pF
C_{rss}	Reverse Transfer Capacitance			211		pF
R_g	Gate resistance	V_{GS}=0V, V_{DS}=0V, f=1MHz		6.7		Ω
SWITCHING PARAMETERS						
Q_g(10V)	Total Gate Charge (10V)	V_{GS}=-10V, V_{DS}=-15V, I_D=-7.1A		30.9		nC
Q_g(4.5V)	Total Gate Charge (4.5V)			16.1		nC
Q_{gs}	Gate Source Charge			8		nC
Q_{gd}	Gate Drain Charge			4.4		nC
$t_{D(on)}$	Turn-On DelayTime	V_{GS}=-10V, V_{DS}=-15V, R_L=2.2Ω, R_{GEN}=3Ω		9.5		ns
t_r	Turn-On Rise Time			8		ns
$t_{D(off)}$	Turn-Off DelayTime			44.2		ns
t_f	Turn-Off Fall Time			22.2		ns
t_{rr}	Body Diode Reverse Recovery Time	I_F=-7.1A, dI/dt=100A/µs		25.5		ns
Q_{rr}	Body Diode Reverse Recovery Charge	I_F=-7.1A, dI/dt=100A/µs		14.7		nC

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1in^2 FR-4 board with 2oz. Copper, in a still air environment with T_A =25°C. The value in any a given application depends on the user's specific board design. The current rating is based on the t≤ 10s thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C. The $R_{\theta JA}$ is the sum of the thermal impedence from junction to lead $R_{\theta JL}$ and lead to ambient.

D. The static characteristics in Figures 1 to 6,12,14 are obtained using 80µs pulses, duty cycle 0.5% max.

E. These tests are performed with the device mounted on 1 in^2 FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The SOA curve provides a single pulse rating.

N-CHANNEL: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

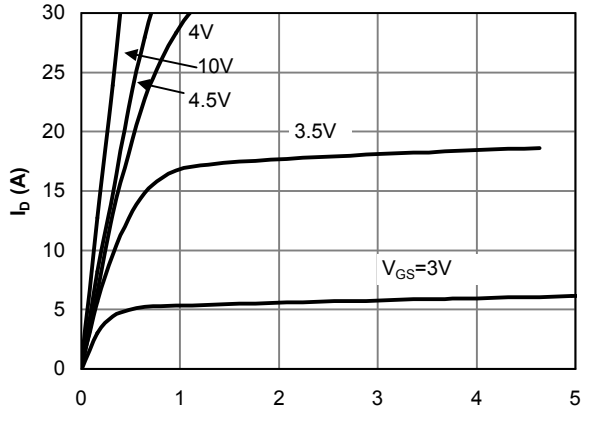


Fig 1: On-Region Characteristics

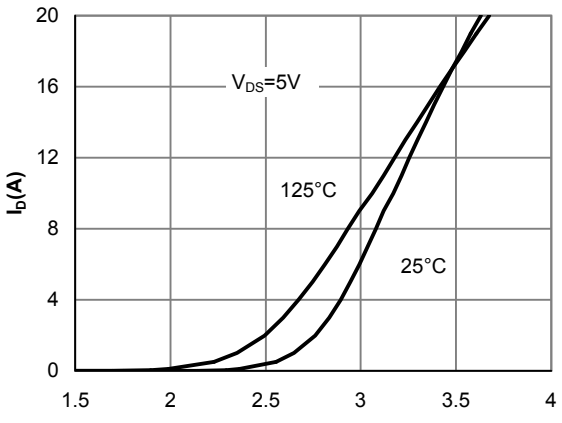


Figure 2: Transfer Characteristics

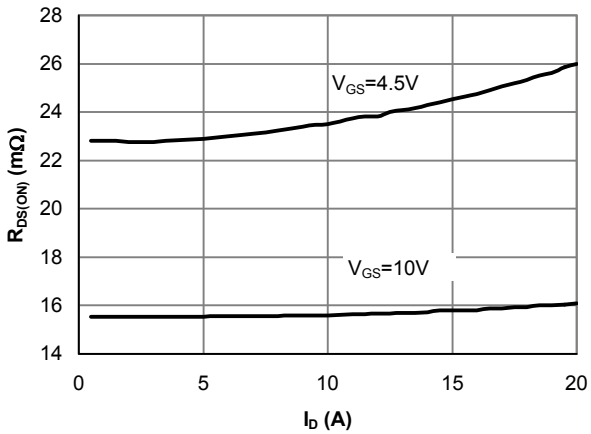


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

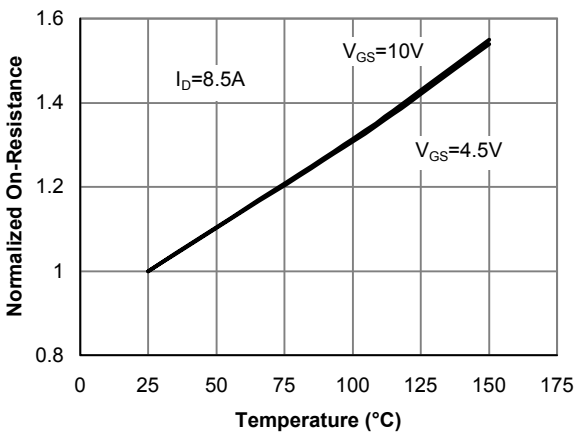


Figure 4: On-Resistance vs. Junction Temperature

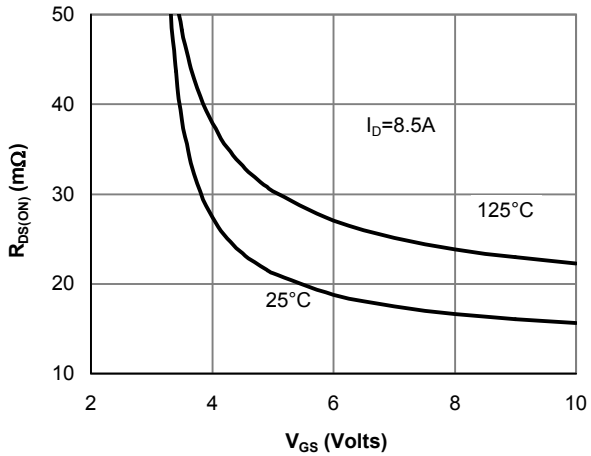


Figure 5: On-Resistance vs. Gate-Source Voltage

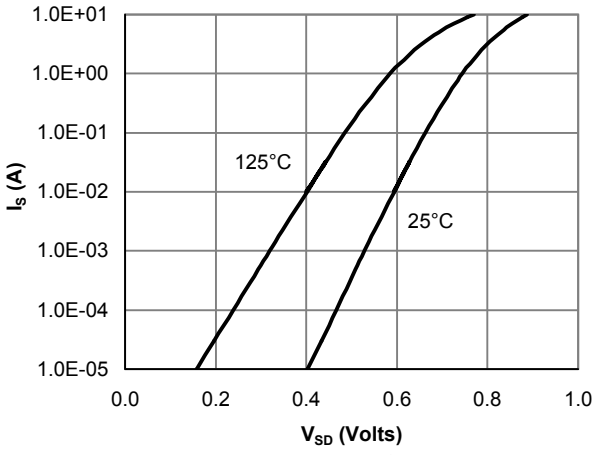


Figure 6: Body-Diode Characteristics

N-CHANNEL: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

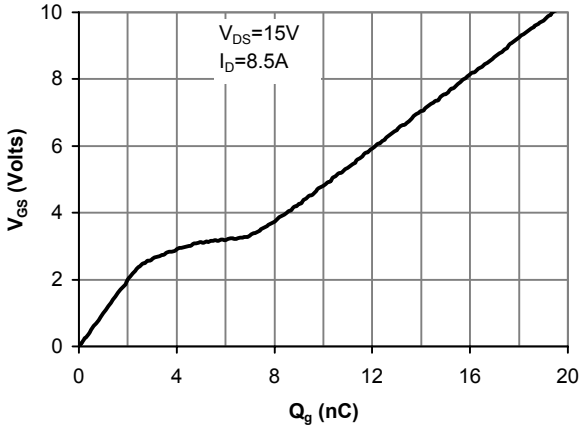


Figure 7: Gate-Charge Characteristics

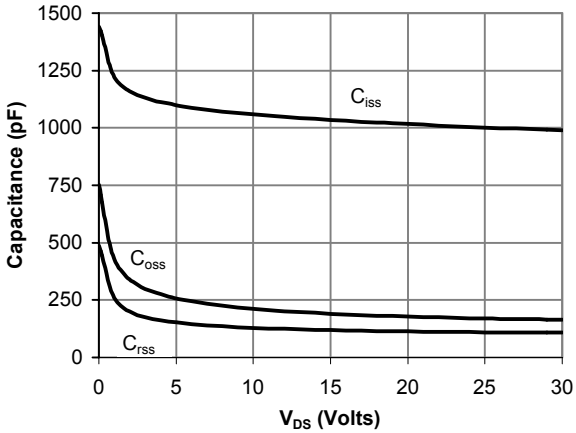


Figure 8: Capacitance Characteristics

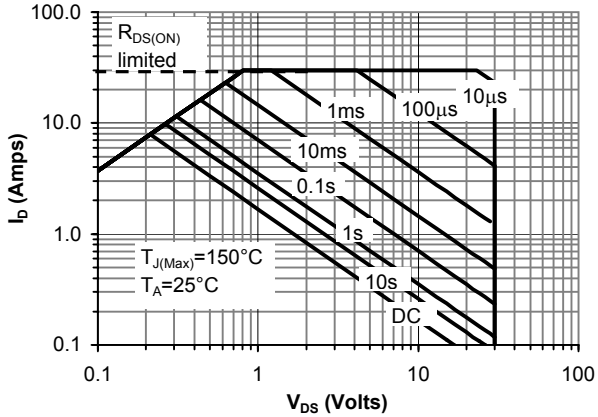


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

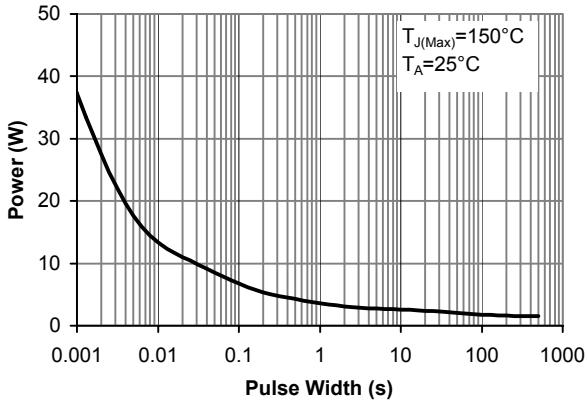


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

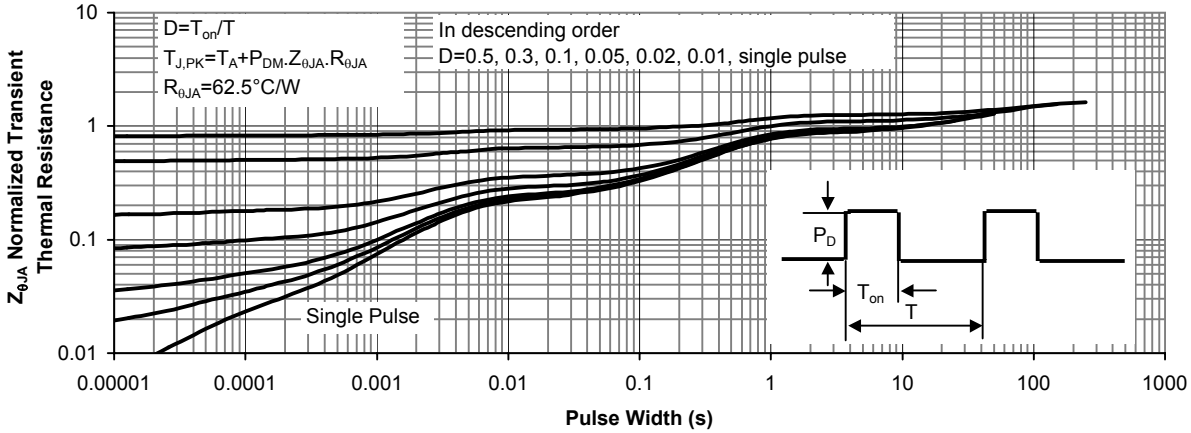


Figure 11: Normalized Maximum Transient Thermal Impedance

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: SCHOTTKY

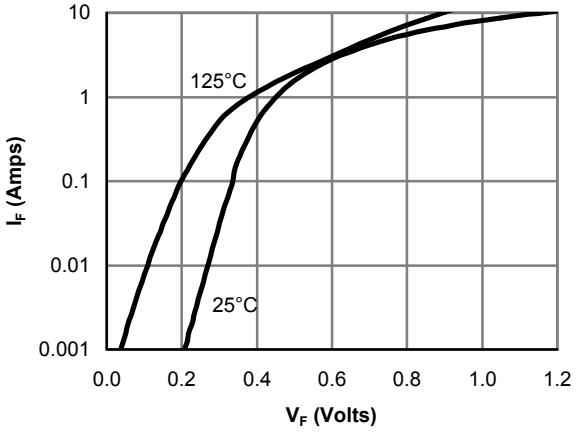


Figure 12: Schottky Forward Characteristics

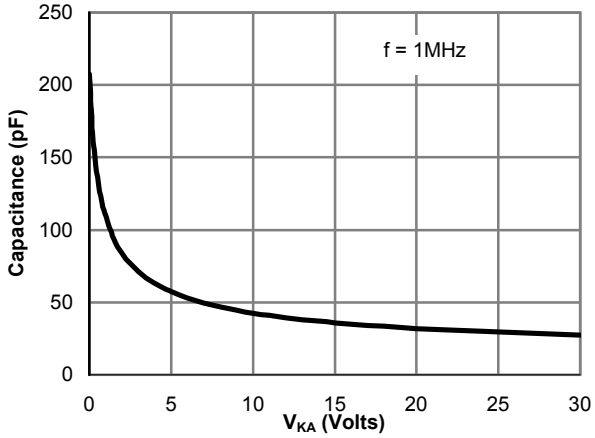


Figure 13: Schottky Capacitance Characteristics

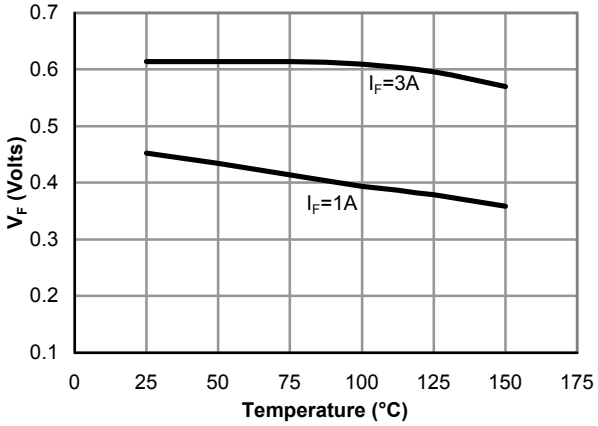


Figure 14: Schottky Forward Drop vs. Junction Temperature

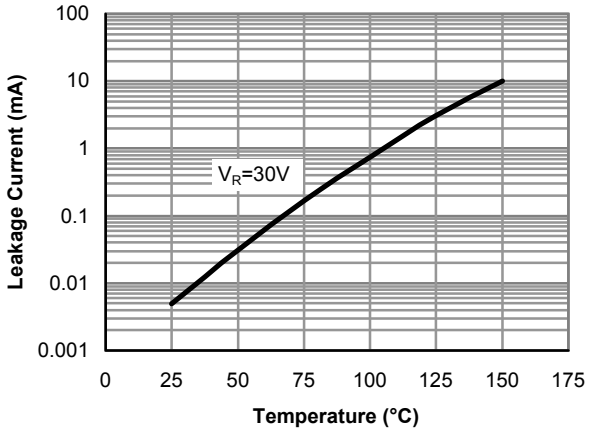


Figure 15: Schottky Leakage current vs. Junction Temperature

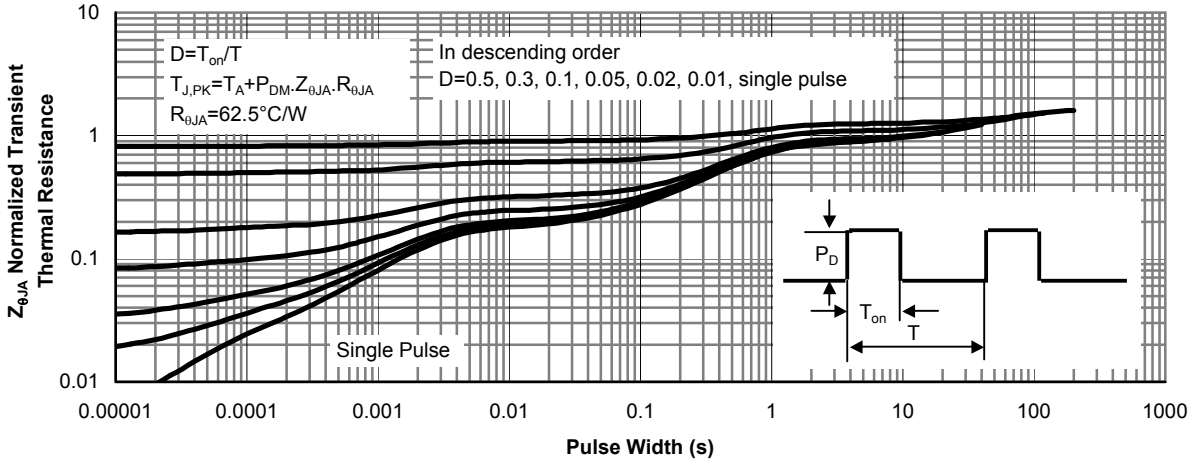


Figure 15: Schottky Normalized Maximum Transient Thermal Impedance

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

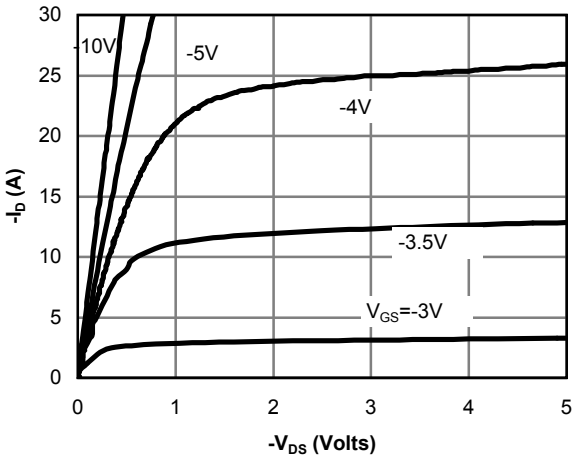


Fig 16: On-Region Characteristics

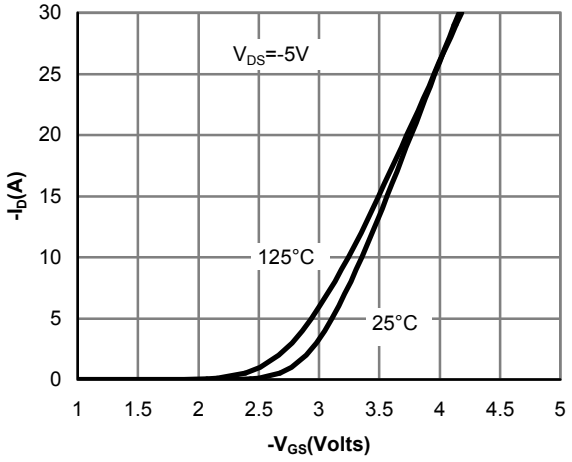


Figure 17: Transfer Characteristics

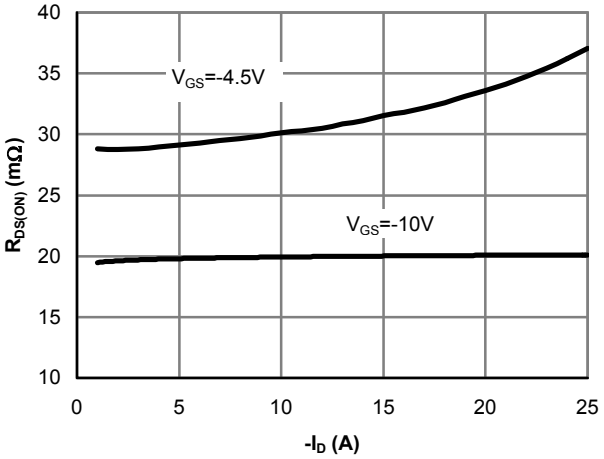


Figure 18: On-Resistance vs. Drain Current and Gate Voltage

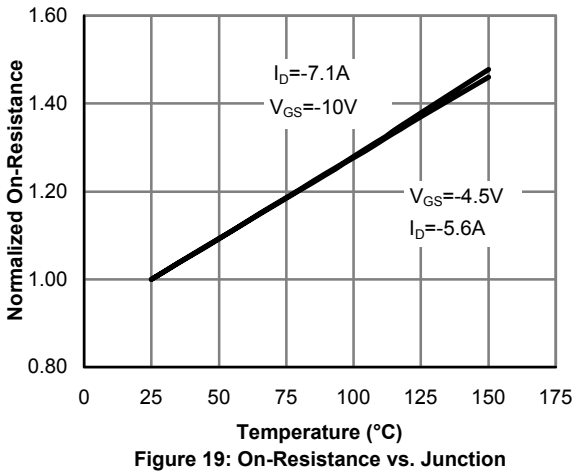


Figure 19: On-Resistance vs. Junction Temperature

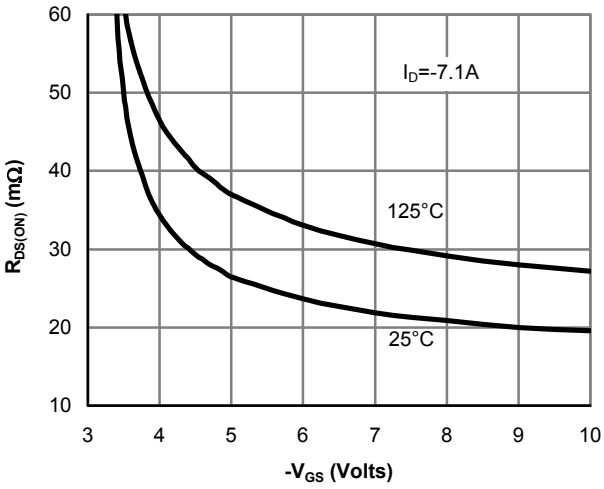


Figure 20: On-Resistance vs. Gate-Source Voltage

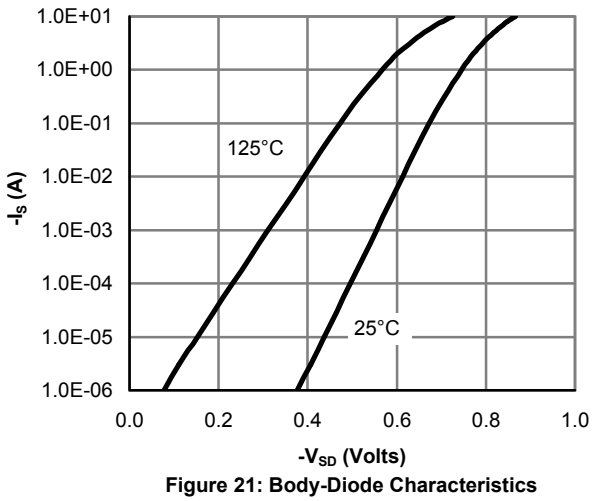


Figure 21: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

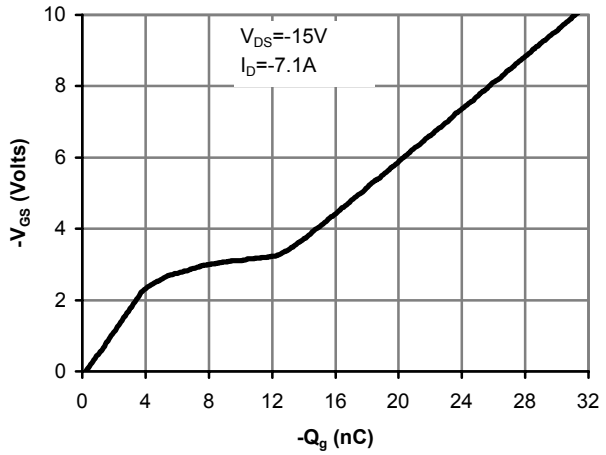


Figure 22: Gate-Charge Characteristics

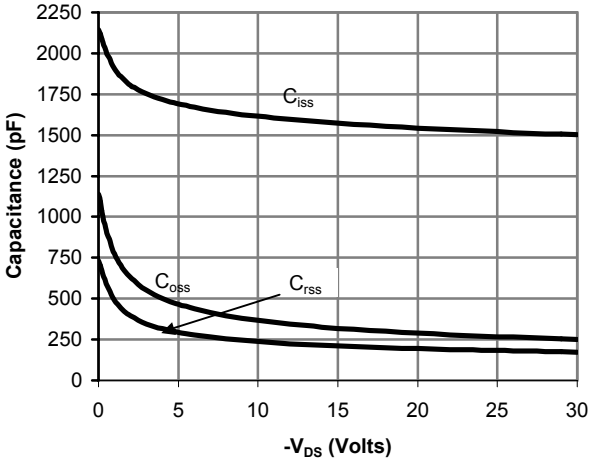


Figure 23: Capacitance Characteristics

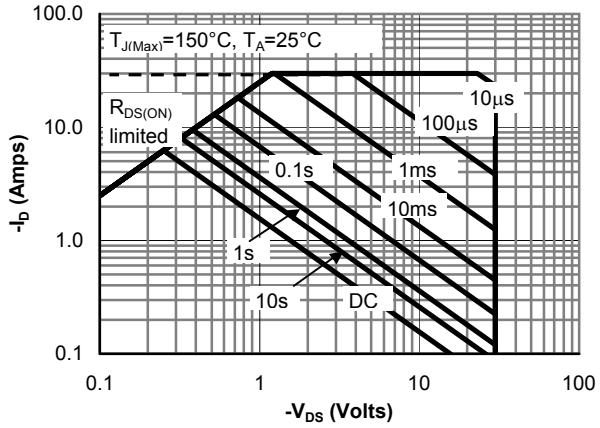


Figure 24: Maximum Forward Biased Safe Operating Area (Note E)

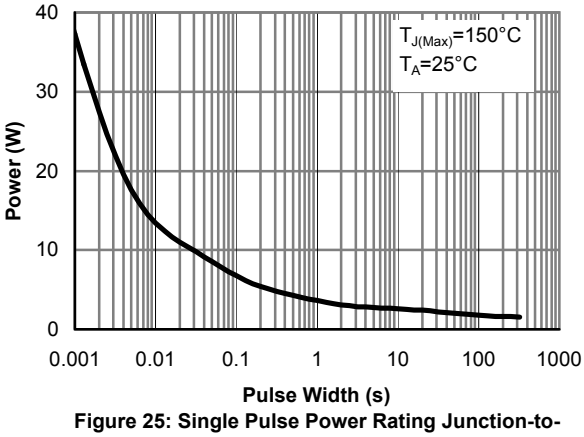


Figure 25: Single Pulse Power Rating Junction-to-Ambient (Note E)

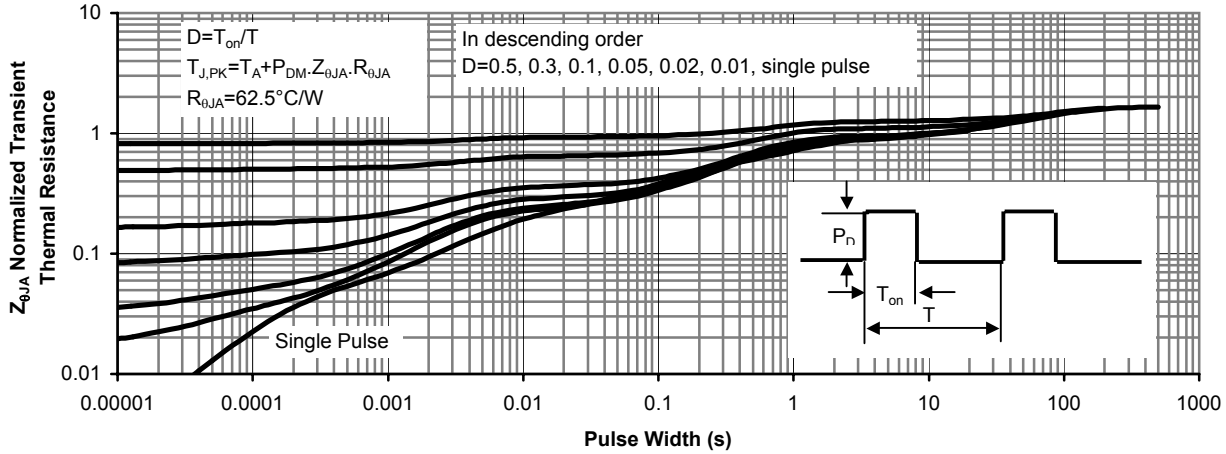


Figure 26: Normalized Maximum Transient Thermal Impedance