



**AO4610**

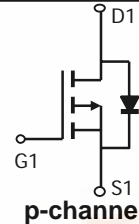
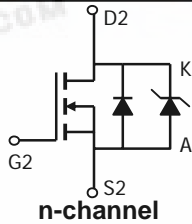
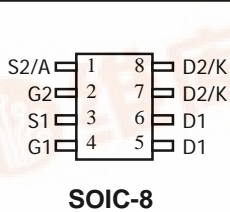
**Complementary Enhancement Mode Field Effect Transistor**

**General Description**

The AO4610 uses advanced trench technology MOSFETs to provide excellent  $R_{DS(ON)}$  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. *Standard Product AO4610 is Pb-free (meets ROHS & Sony 259 specifications). AO4610L is a Green Product ordering option. AO4610 and AO4610L are electrically identical.*

**Features**

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



**Absolute Maximum Ratings  $T_A=25^\circ C$  unless otherwise noted**

Parameter	Symbol	Max n-channel	Max p-channel	Units
Drain-Source Voltage	$V_{DS}$	30	-30	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	$\pm 20$	V
Continuous Drain Current <sup>A</sup>	$I_D$	8.5	-7.1	A
$T_A=70^\circ C$		6.6	-5.6	
Pulsed Drain Current <sup>B</sup>	$I_{DM}$	30	-30	
Power Dissipation	$P_D$	2	2	W
		$T_A=70^\circ C$	1.28	
Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to 150	-55 to 150	$^\circ C$

Parameter	Symbol	Maximum Schottky	Units
Reverse Voltage	$V_{DS}$	30	V
Continuous Forward Current <sup>A</sup>	$I_D$	3	A
$T_A=70^\circ C$		2	
Pulsed Forward Current <sup>B</sup>	$I_{DM}$	20	
Power Dissipation <sup>A</sup>	$P_D$	2	W
		$T_A=70^\circ C$	
Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to 150	$^\circ C$



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

N-Channel + Schottky Electrical Characteristics (T<sub>J</sub>=25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>STATIC PARAMETERS</b>						
BV <sub>DSS</sub>	Drain-Source Breakdown Voltage	I <sub>D</sub> =250μA, V <sub>GS</sub> =0V	30			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> =24V, V <sub>GS</sub> =0V T <sub>J</sub> =55°C			25	μA
I <sub>GSS</sub>	Gate-Body leakage current	V <sub>DS</sub> =0V, V <sub>GS</sub> =±20V			100	nA
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> =V <sub>GS</sub> I <sub>D</sub> =250μA	1	1.8	3	V
I <sub>D(ON)</sub>	On state drain current	V <sub>GS</sub> =4.5V, V <sub>DS</sub> =5V	40			A
R <sub>DS(ON)</sub>	Static Drain-Source On-Resistance	V <sub>GS</sub> =10V, I <sub>D</sub> =8.5A T <sub>J</sub> =125°C		15.5	18	mΩ
		V <sub>GS</sub> =4.5V, I <sub>D</sub> =6.6A		22.3	27	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> =5V, I <sub>D</sub> =8.5A	10	23		S
V <sub>SD</sub>	Body-Diode+Schottky Forward Voltage	I <sub>S</sub> =1A		0.75	1	V
I <sub>S</sub>	Maximum Body-Diode+Schottky Continuous Current				5.5	A
<b>DYNAMIC PARAMETERS</b>						
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> =0V, V <sub>DS</sub> =15V, f=1MHz		1040		pF
C <sub>oss</sub>	Output Capacitance (FET+Schottky)			180		pF
C <sub>riss</sub>	Reverse Transfer Capacitance			110		pF
R <sub>g</sub>	Gate resistance	V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz		0.7		Ω
<b>SWITCHING PARAMETERS</b>						
Q <sub>g</sub> (10V)	Total Gate Charge	V <sub>GS</sub> =10V, V <sub>DS</sub> =15V, I <sub>D</sub> =8.5A		19.2		nC
Q <sub>g</sub> (4.5V)	Total Gate Charge			9.36		nC
Q <sub>gs</sub>	Gate Source Charge			2.6		nC
Q <sub>gd</sub>	Gate Drain Charge			4.2		nC
t <sub>D(on)</sub>	Turn-On DelayTime	V <sub>GS</sub> =10V, V <sub>DS</sub> =15V, R <sub>L</sub> =1.8Ω, R <sub>GEN</sub> =3Ω		5.2		ns
t <sub>r</sub>	Turn-On Rise Time			4.4		ns
t <sub>D(off)</sub>	Turn-Off DelayTime			17.3		ns
t <sub>f</sub>	Turn-Off Fall Time			3.3		ns
t <sub>rr</sub>	Body-Diode+Schottky Reverse Recovery Time	I <sub>F</sub> =8.5A, dI/dt=100A/μs		16.7		ns
Q <sub>rr</sub>	Body-Diode+Schottky Reverse Recovery Charge	I <sub>F</sub> =8.5A, dI/dt=100A/μs		6.7		nC
<b>SCHOTTKY PARAMETERS</b>						
V <sub>F</sub>	Forward Voltage Drop	I <sub>F</sub> =1.0A		0.45	0.5	V
I <sub>rm</sub>	Maximum reverse leakage current	V <sub>R</sub> =30V		0.007	0.05	mA
		V <sub>R</sub> =30V, T <sub>J</sub> =125°C		3.2	10	
		V <sub>R</sub> =30V, T <sub>J</sub> =150°C		12	20	
C <sub>T</sub>	Junction Capacitance	V <sub>R</sub> =15V		37		pF

A: The value of R<sub>θJA</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25°C. The value in any other 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<sub>θJA</sub> is the sum of the thermal impedance from junction to lead R<sub>θJL</sub> and lead to ambient.

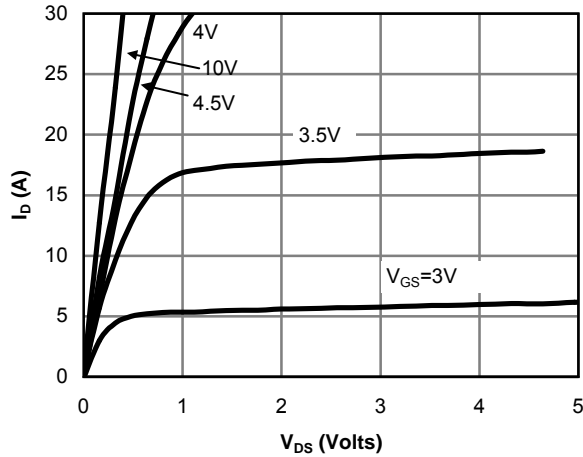
D: The static characteristics in Figures 1 to 6 are obtained using 80 μs pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25°C. The SOA curve provides a single pulse rating.

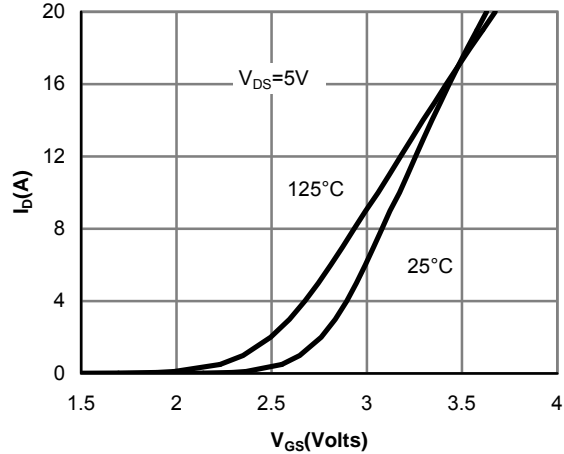
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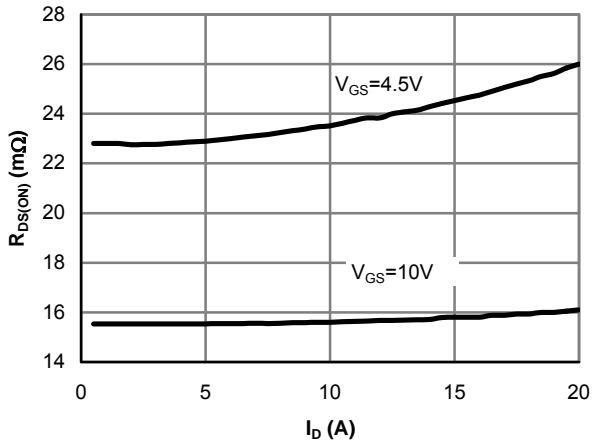
**N-CHANNEL: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



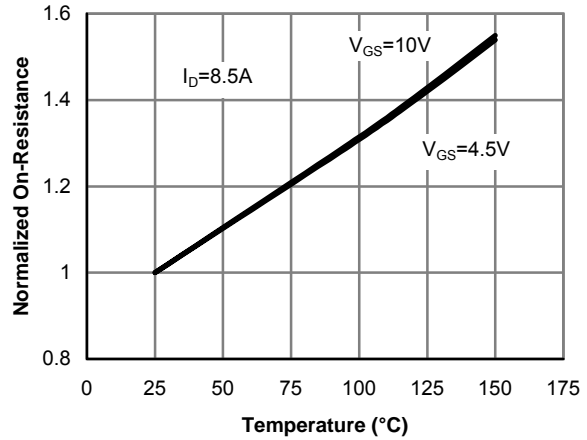
**Fig 1: On-Region Characteristics**



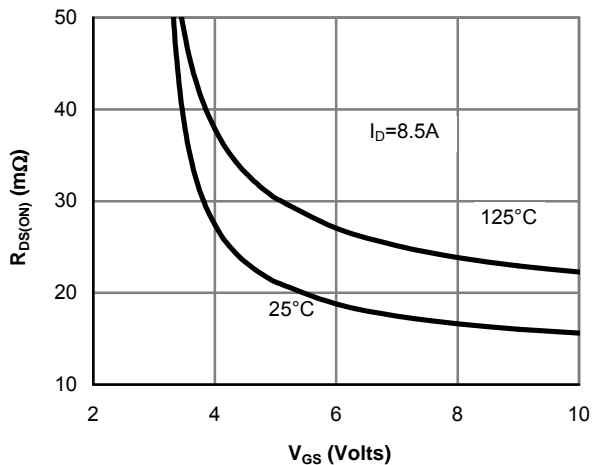
**Figure 2: Transfer Characteristics**



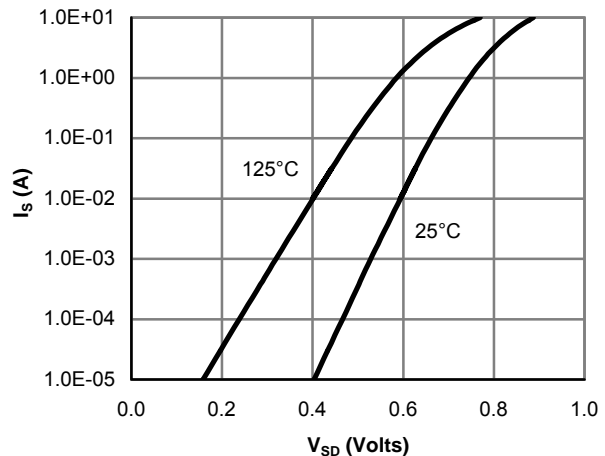
**Figure 3: On-Resistance vs. Drain Current and Gate Voltage**



**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

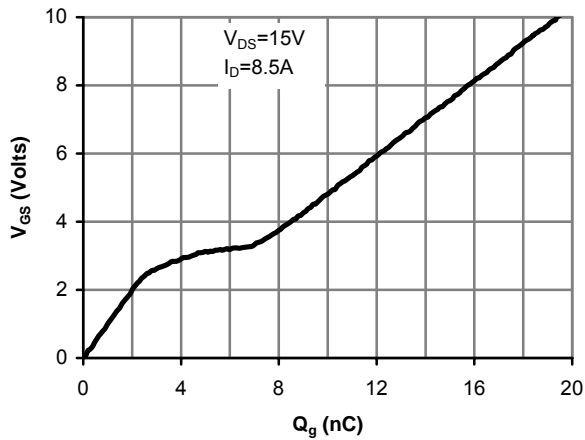


Figure 7: Gate-Charge Characteristics

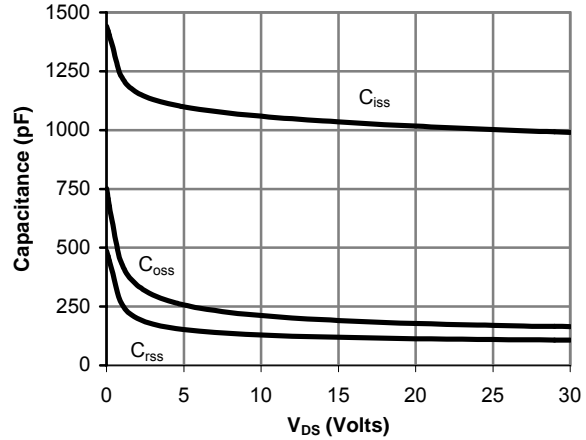


Figure 8: Capacitance Characteristics

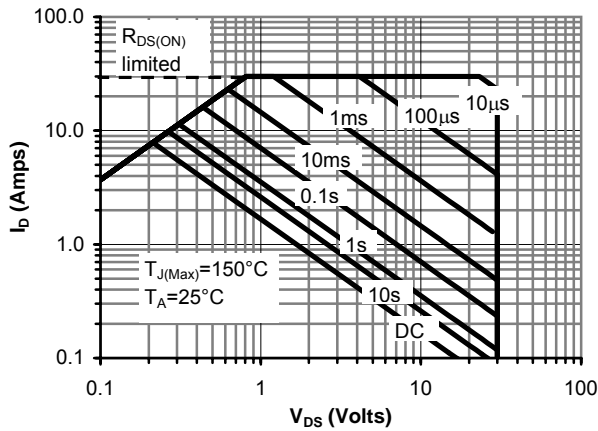


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

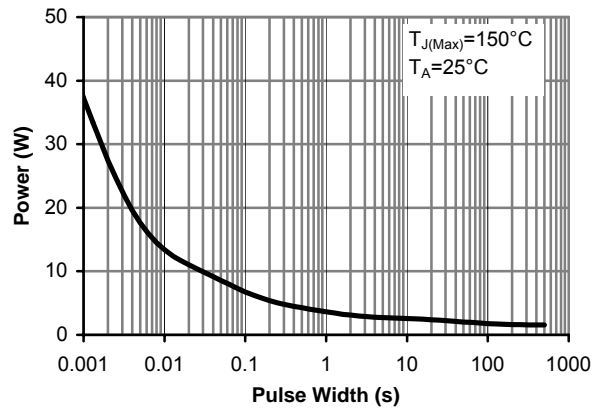


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

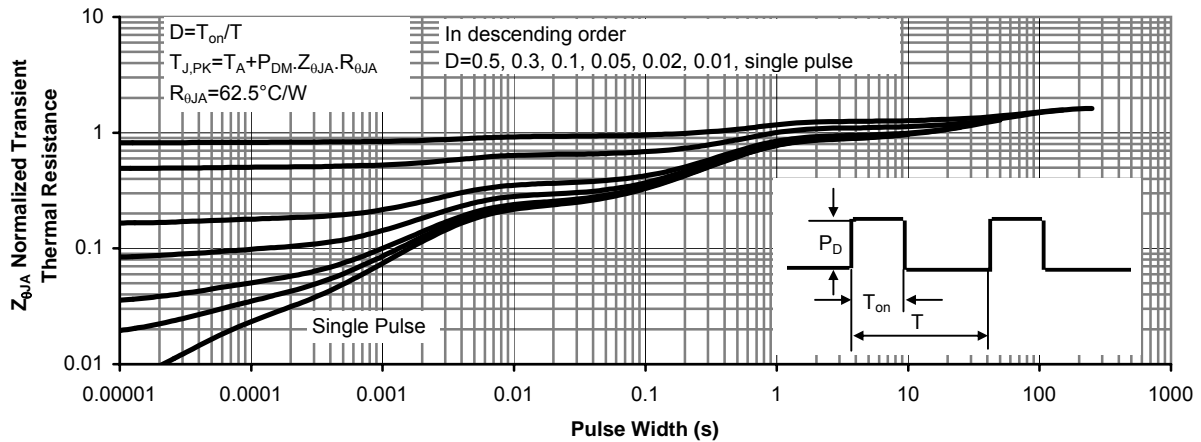


Figure 11: Normalized Maximum Transient Thermal Impedance

P-Channel Electrical Characteristics ( $T_J=25^\circ\text{C}$  unless otherwise noted)

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

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

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

C: The  $R_{\theta JA}$  is the sum of the thermal impedance 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 80  $\mu\text{s}$  pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with  $T_A=25^\circ\text{C}$ . The SOA curve provides a single pulse rating.

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

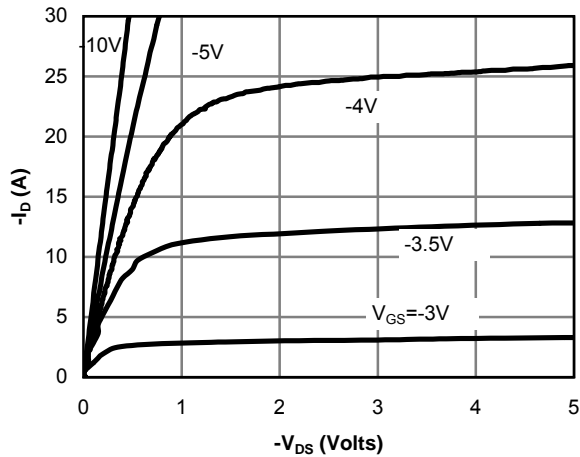


Fig 16: On-Region Characteristics

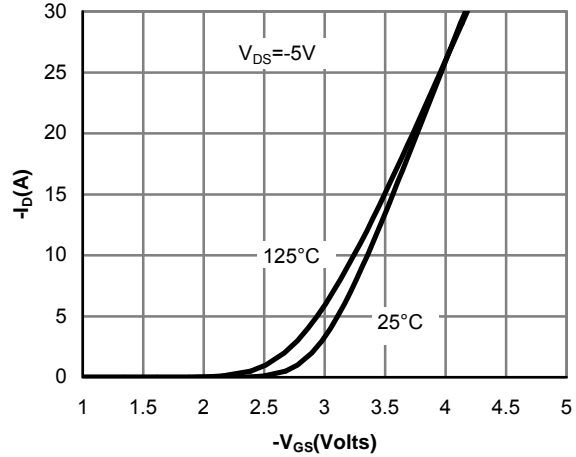


Figure 17: Transfer Characteristics

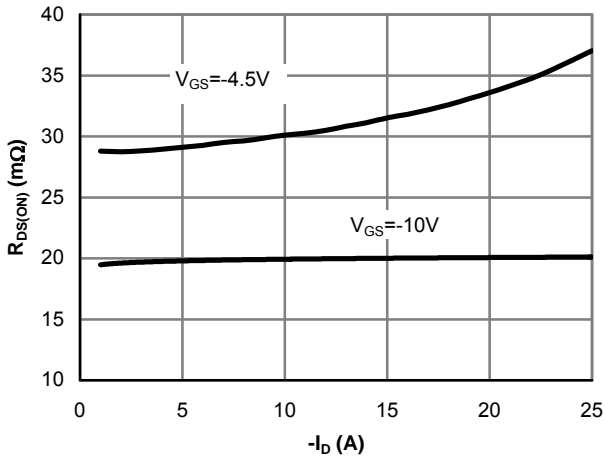


Figure 18: On-Resistance vs. Drain Current and Gate Voltage

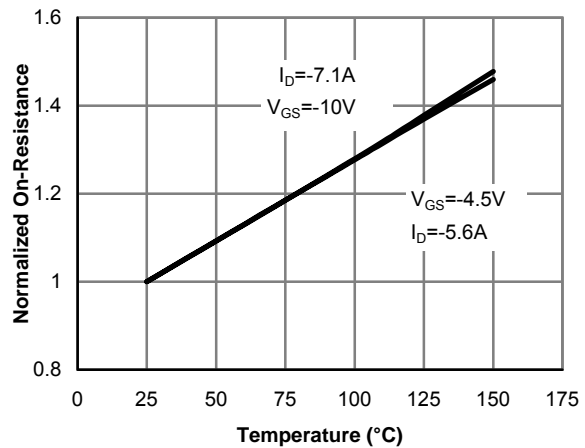


Figure 19: On-Resistance vs. Junction Temperature

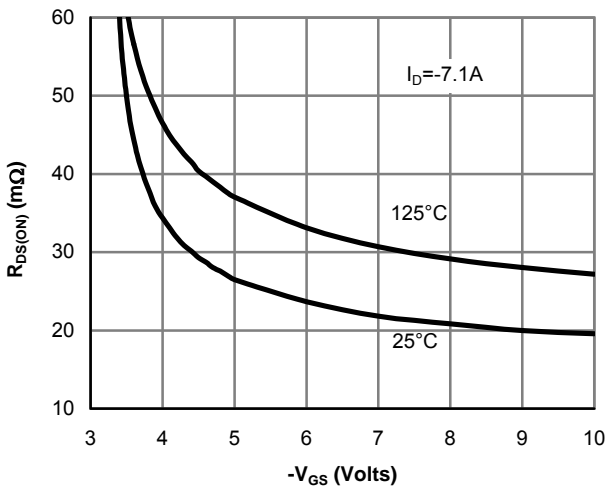


Figure 20: On-Resistance vs. Gate-Source Voltage

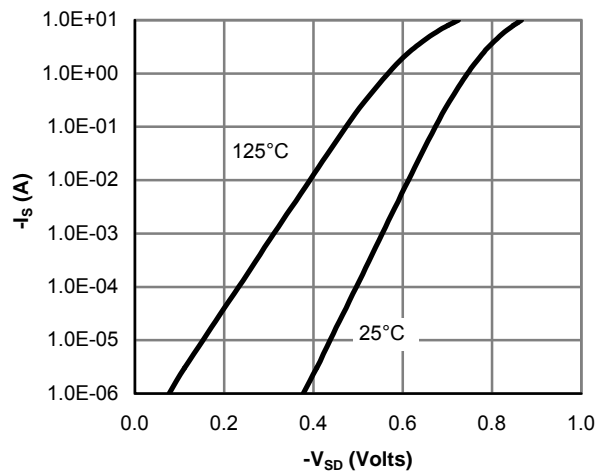


Figure 21: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

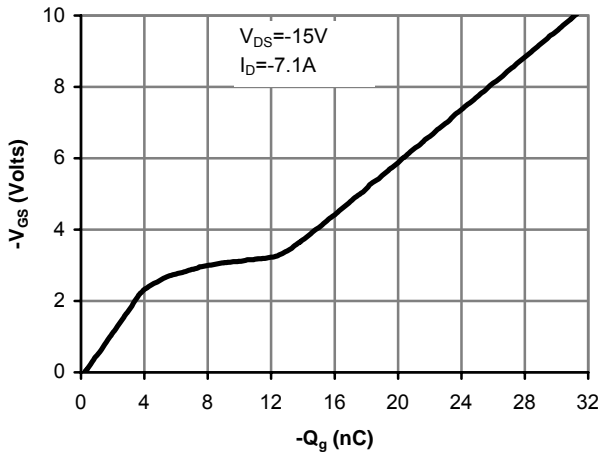


Figure 22: Gate-Charge Characteristics

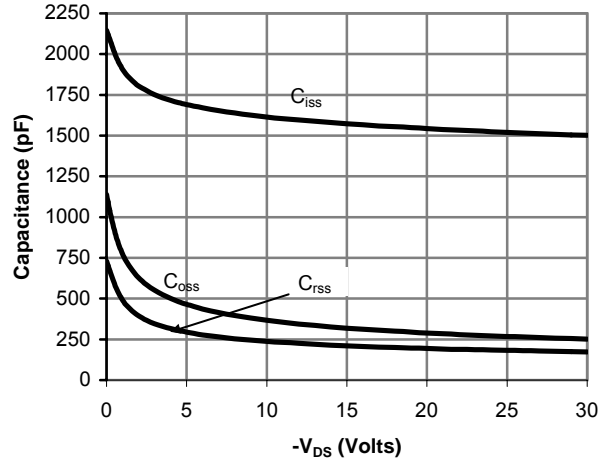


Figure 23: Capacitance Characteristics

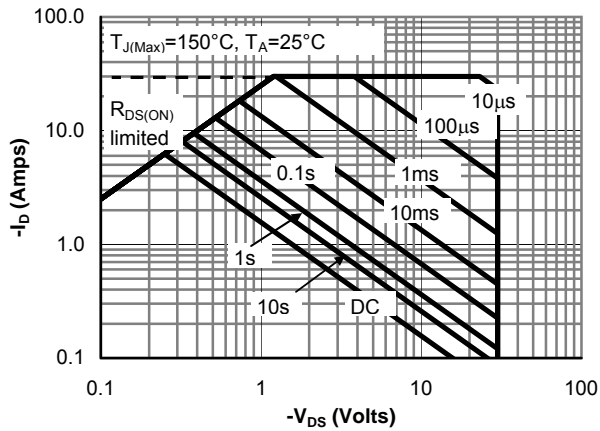


Figure 24: Maximum Forward Biased Safe Operating Area (Note E)

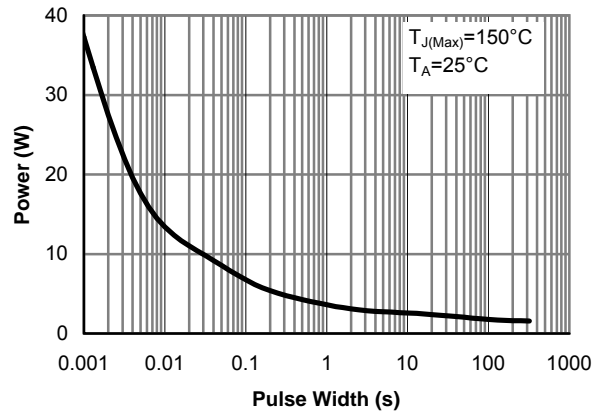


Figure 25: Single Pulse Power Rating Junction-to-Ambient (Note E)

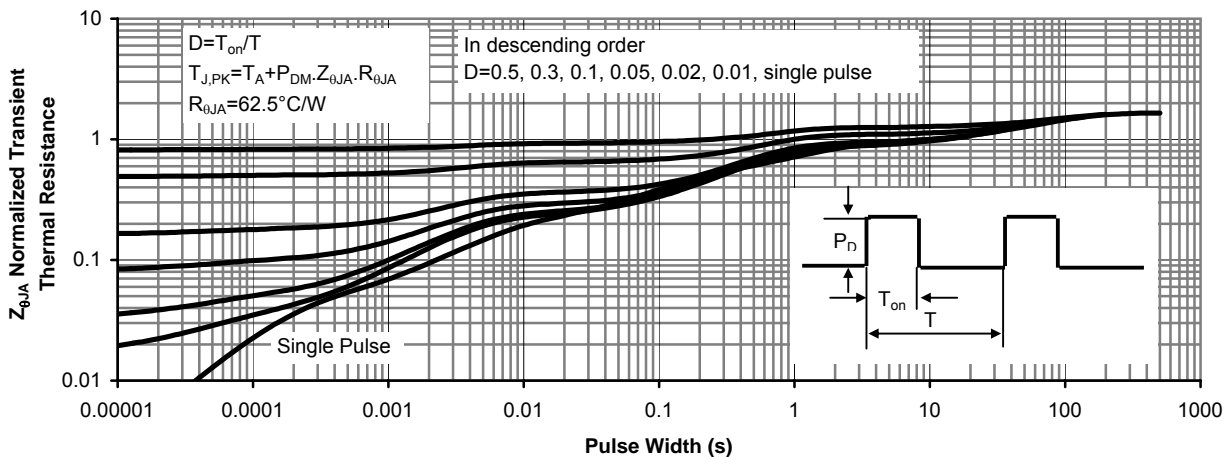


Figure 26: Normalized Maximum Transient Thermal Impedance



TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: SCHOTTKY

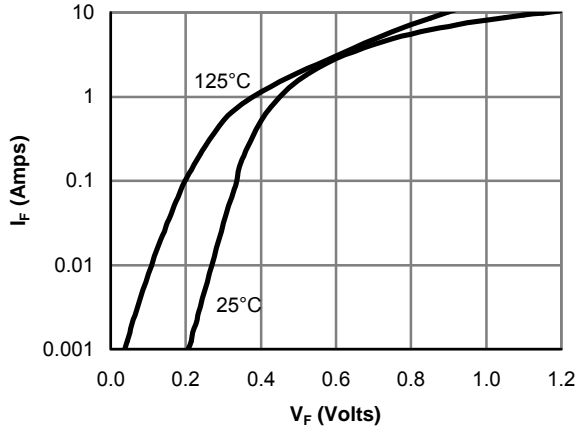


Figure 12: Schottky Forward Characteristics

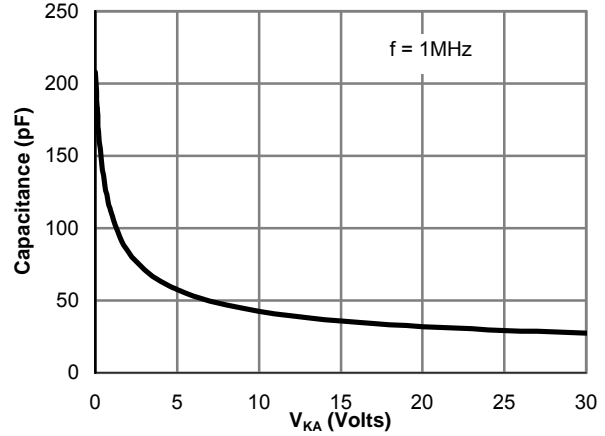


Figure 13: Schottky Capacitance Characteristics

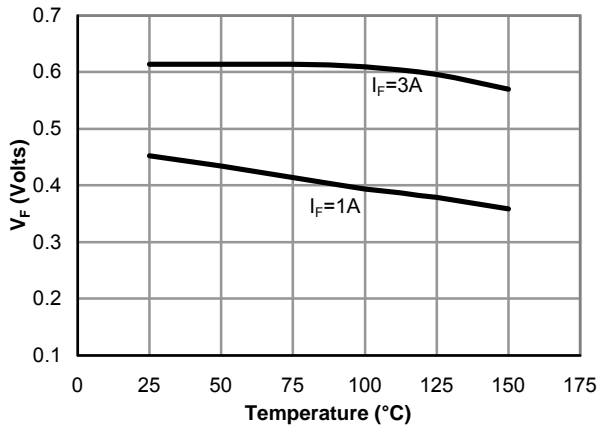


Figure 14: Schottky Forward Drop vs. Junction Temperature

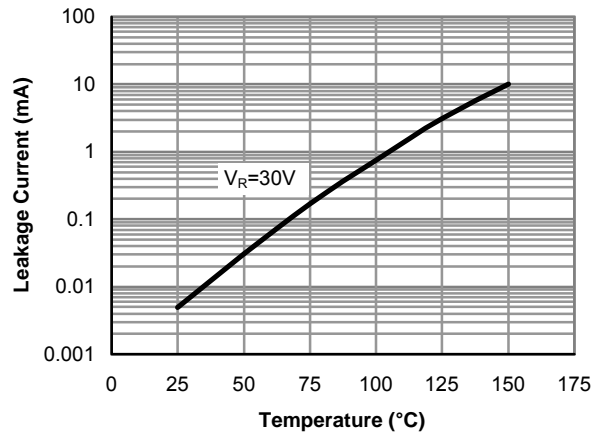


Figure 15: Schottky Leakage current vs. Junction Temperature

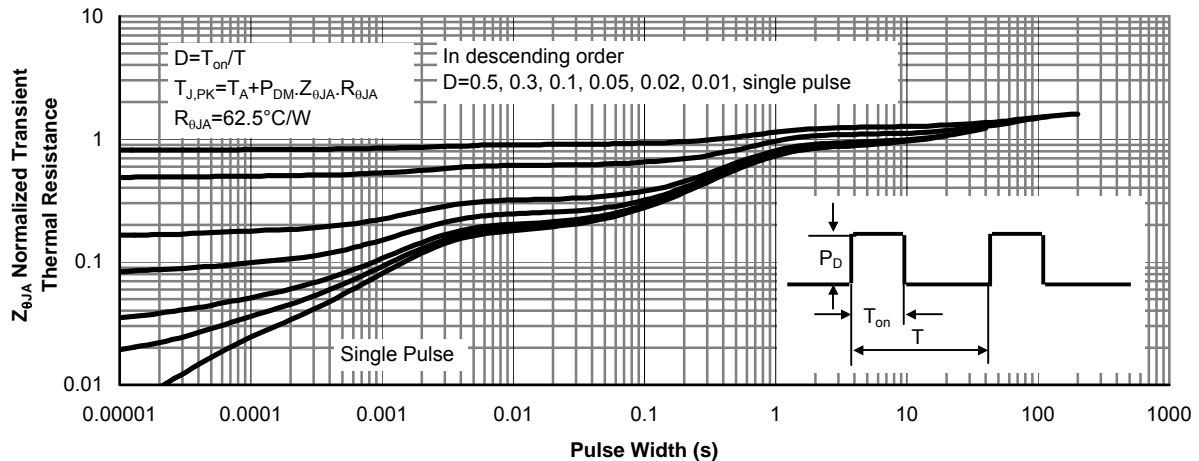


Figure 15: Schottky Normalized Maximum Transient Thermal Impedance