



## AOP609

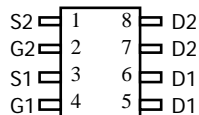
### Complementary Enhancement Mode Field Effect Transistor

#### General Description

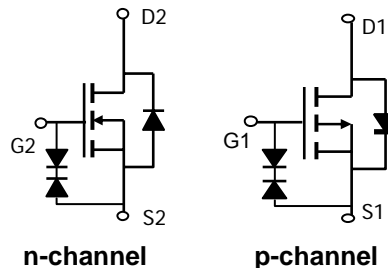
The AOP609 uses advanced trench technology MOSFETs to provide excellent  $R_{DS(ON)}$  and low gate charge. The complementary MOSFETs may be used in H-bridge, Inverters and other applications. *Standard Product AOP609 is Pb-free (meets ROHS & Sony 259 specifications). AOP609L is a Green Product ordering option. AOP609 and AOP609L are electrically identical.*

#### Features

n-channel	p-channel
$V_{DS}$ (V) = 60V	-60V
$I_D$ = 4.7A ( $V_{GS}=10V$ )	-3.5A ( $V_{GS}=-10V$ )
$R_{DS(ON)}$	$R_{DS(ON)}$
< 60m $\Omega$ ( $V_{GS}=10V$ )	< 115m $\Omega$ ( $V_{GS}=-10V$ )
< 75m $\Omega$ ( $V_{GS}=4.5V$ )	< 140m $\Omega$ ( $V_{GS}=-4.5V$ )
ESD Rating: 1500V HBM	3000V HMB



PDIP-8



n-channel

p-channel

#### Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted

Parameter	Symbol	Max n-channel	Max p-channel	Units
Drain-Source Voltage	$V_{DS}$	60	-60	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	$\pm 20$	V
Continuous Drain Current <sup>A</sup>	$I_D$	4.7	-3.5	A
$T_A=25^\circ\text{C}$		3.8	-2.9	
Pulsed Drain Current <sup>B</sup>	$I_{DM}$	20	-20	
Power Dissipation	$P_D$	2.5	2.5	W
		$T_A=25^\circ\text{C}$	1.6	
Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to 150	-55 to 150	$^\circ\text{C}$

#### Thermal Characteristics: n-channel and p-channel

Parameter	Symbol	Device	Typ	Max	Units
Maximum Junction-to-Ambient <sup>A</sup>	$R_{\theta JA}$	n-ch	37	50	$^\circ\text{C/W}$
$t \leq 10\text{s}$		n-ch	74	90	$^\circ\text{C/W}$
Maximum Junction-to-Ambient <sup>A</sup>	$R_{\theta JA}$	p-ch	35	50	$^\circ\text{C/W}$
Steady-State		p-ch	73	90	$^\circ\text{C/W}$
Maximum Junction-to-Lead <sup>C</sup>	$R_{\theta JL}$	n-ch	28	40	$^\circ\text{C/W}$
Steady-State		p-ch	32	40	$^\circ\text{C/W}$

N 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	$I_D=250\mu\text{A}$ , $V_{GS}=0\text{V}$	60			V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS}=48\text{V}$ , $V_{GS}=0\text{V}$ $T_J=55^\circ\text{C}$			1	$\mu\text{A}$
					5	
$I_{GSS}$	Gate-Body leakage current	$V_{DS}=0\text{V}$ , $V_{GS}=\pm 20\text{V}$			250	$\mu\text{A}$
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}$ , $I_D=250\mu\text{A}$	1.5	2.4	3	V
$I_{D(ON)}$	On state drain current	$V_{GS}=10\text{V}$ , $V_{DS}=5\text{V}$	20			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS}=10\text{V}$ , $I_D=4.7\text{A}$ $T_J=125^\circ\text{C}$		49	60	m $\Omega$
				65		
		$V_{GS}=4.5\text{V}$ , $I_D=3.0\text{A}$		57	75	m $\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS}=5\text{V}$ , $I_D=4.7\text{A}$		17		S
$V_{SD}$	Diode Forward Voltage	$I_S=1\text{A}$ , $V_{GS}=0\text{V}$		0.78	1	V
$I_S$	Maximum Body-Diode Continuous Current				3.5	A
<b>DYNAMIC PARAMETERS</b>						
$C_{iss}$	Input Capacitance	$V_{GS}=0\text{V}$ , $V_{DS}=30\text{V}$ , $f=1\text{MHz}$		474	570	pF
$C_{oss}$	Output Capacitance			157		pF
$C_{riss}$	Reverse Transfer Capacitance			60		pF
$R_g$	Gate resistance	$V_{GS}=0\text{V}$ , $V_{DS}=0\text{V}$ , $f=1\text{MHz}$		1.65	2	$\Omega$
<b>SWITCHING PARAMETERS</b>						
$Q_g(10\text{V})$	Total Gate Charge	$V_{GS}=10\text{V}$ , $V_{DS}=30\text{V}$ , $I_D=4.7\text{A}$		5.1	7	nC
$Q_g(4.5\text{V})$	Total Gate Charge			2.5	3	nC
$Q_{gs}$	Gate Source Charge			1		nC
$Q_{gd}$	Gate Drain Charge			1.4		nC
$t_{D(on)}$	Turn-On Delay Time	$V_{GS}=10\text{V}$ , $V_{DS}=30\text{V}$ , $R_L=6\Omega$ , $R_{GEN}=3\Omega$		5.4		ns
$t_r$	Turn-On Rise Time			5.5		ns
$t_{D(off)}$	Turn-Off Delay Time			17.2		ns
$t_f$	Turn-Off Fall Time			2.9		ns
$t_{rr}$	Body Diode Reverse Recovery Time		$I_F=4.7\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		25.4	35
$Q_{rr}$	Body Diode Reverse Recovery Charge	$I_F=4.7\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		29.4		nC

A: The value of  $R_{\theta JA}$  is measured with the device mounted on 1in<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.

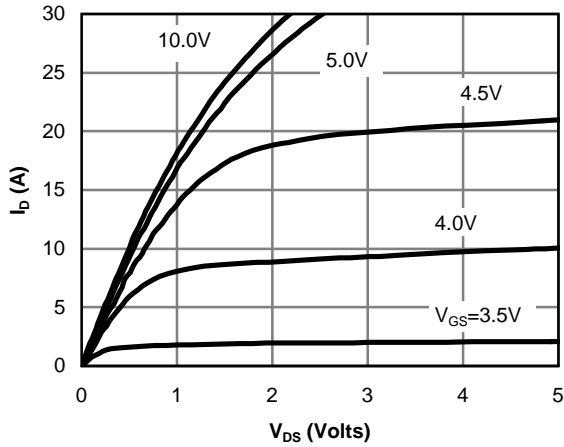
D: The static characteristics in Figures 1 to 6 are obtained using 80 $\mu\text{s}$  pulses, duty cycle 0.5% max.

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.

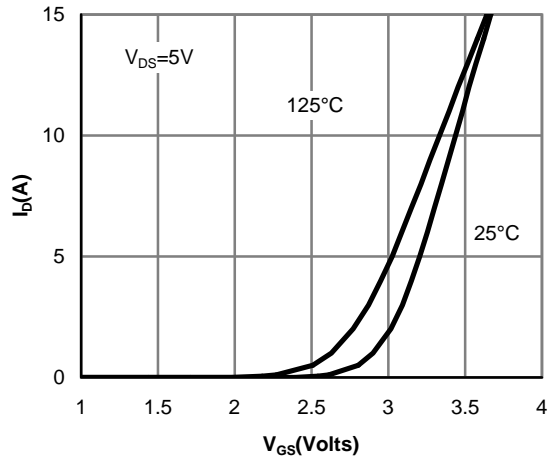
Rev 1 : December 2005

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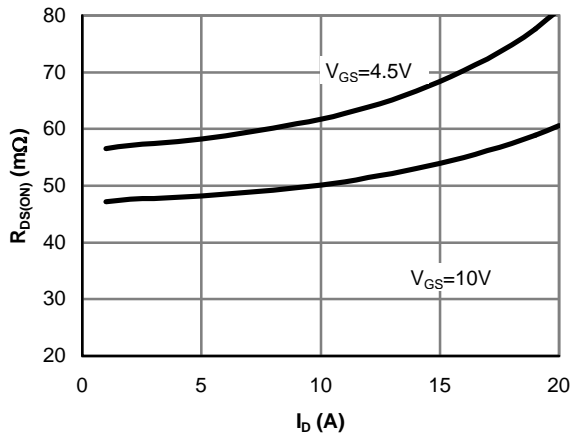
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL**



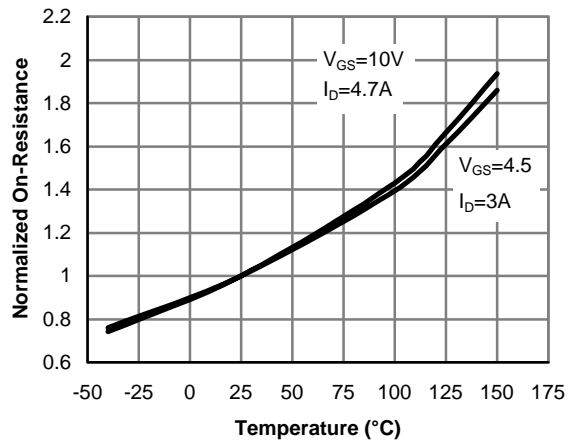
**Fig 1: On-Region Characteristics**



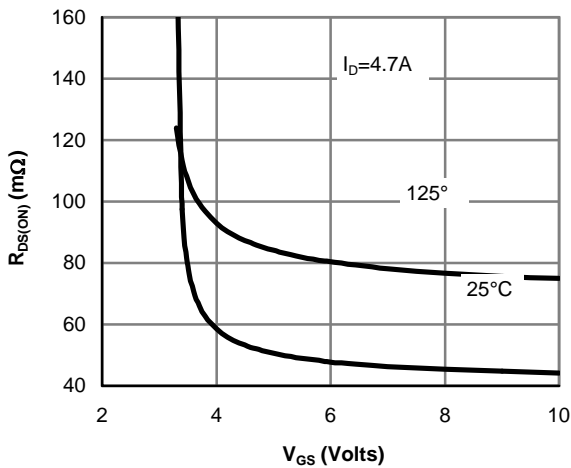
**Figure 2: Transfer Characteristics**



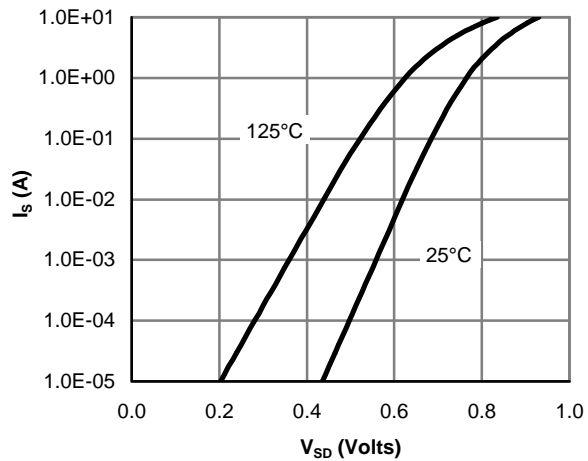
**Figure 3: On-Resistance vs. Drain Current and Gate Voltage**



**Figure 4: On-Resistance vs. Junction Temperature**



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



**Figure 6: Body-Diode Characteristics**

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL

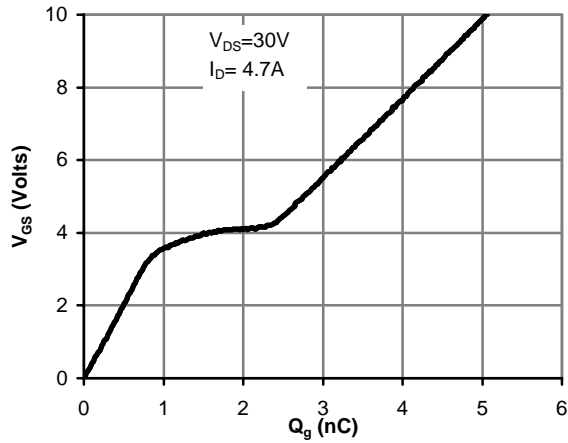


Figure 7: Gate-Charge Characteristics

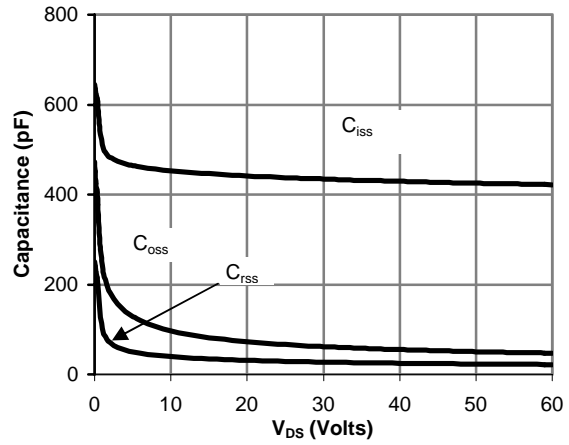


Figure 8: Capacitance Characteristics

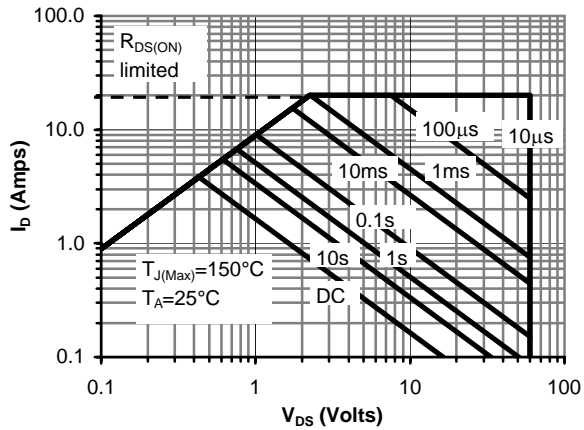


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

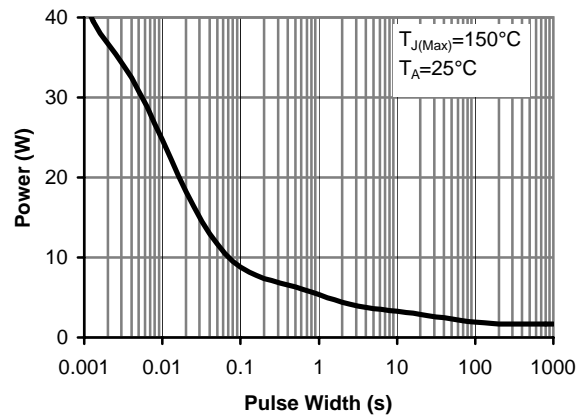


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

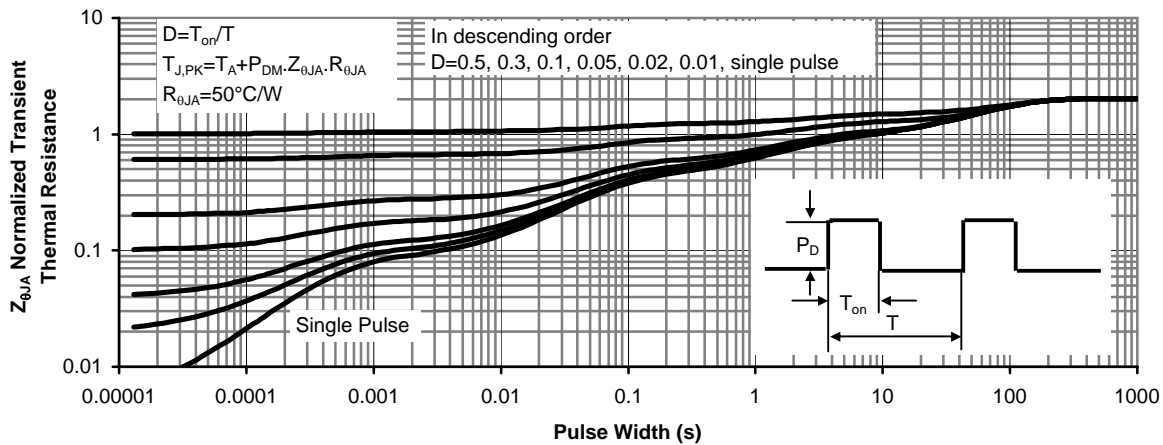


Figure 11: Normalized Maximum Transient Thermal Impedance

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	$I_D=-250\mu\text{A}$ , $V_{GS}=0\text{V}$	-60			V	
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS}=-48\text{V}$ , $V_{GS}=0\text{V}$ $T_J=55^\circ\text{C}$			-1	$\mu\text{A}$	
					-5		
$I_{GSS}$	Gate-Body leakage current	$V_{DS}=0\text{V}$ , $V_{GS}=\pm 20\text{V}$			100	$\mu\text{A}$	
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}$ , $I_D=-250\mu\text{A}$	-1.5	-1.8	-3	V	
$I_{D(ON)}$	On state drain current	$V_{GS}=-10\text{V}$ , $V_{DS}=-5\text{V}$	-20			A	
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS}=-10\text{V}$ , $I_D=-3.5\text{A}$ $T_J=125^\circ\text{C}$		95	115	m $\Omega$	
				133			
		$V_{GS}=-4.5\text{V}$ , $I_D=-2.8\text{A}$		112	140	m $\Omega$	
$g_{FS}$	Forward Transconductance	$V_{DS}=-5\text{V}$ , $I_D=-3.5\text{A}$		9		S	
$V_{SD}$	Diode Forward Voltage	$I_S=-1\text{A}$ , $V_{GS}=0\text{V}$		-0.77	-1	V	
$I_S$	Maximum Body-Diode Continuous Current				-3.5	A	
<b>DYNAMIC PARAMETERS</b>							
$C_{iss}$	Input Capacitance	$V_{GS}=0\text{V}$ , $V_{DS}=-30\text{V}$ , $f=1\text{MHz}$		897	1080	pF	
$C_{oss}$	Output Capacitance			88		pF	
$C_{rss}$	Reverse Transfer Capacitance			36		pF	
$R_g$	Gate resistance	$V_{GS}=0\text{V}$ , $V_{DS}=0\text{V}$ , $f=1\text{MHz}$		7.2	9	$\Omega$	
<b>SWITCHING PARAMETERS</b>							
$Q_g(10\text{V})$	Total Gate Charge (10V)	$V_{GS}=-10\text{V}$ , $V_{DS}=-30\text{V}$ , $I_D=-3.5\text{A}$		8.1	10	nC	
$Q_g(4.5\text{V})$	Total Gate Charge (4.5V)			3.9	5	nC	
$Q_{gs}$	Gate Source Charge			1.4		nC	
$Q_{gd}$	Gate Drain Charge			1.7		nC	
$t_{D(on)}$	Turn-On Delay Time				9		ns
$t_r$	Turn-On Rise Time	$V_{GS}=-10\text{V}$ , $V_{DS}=-30\text{V}$ , $R_L=8.1\Omega$ , $R_{GEN}=3\Omega$		7.2		ns	
$t_{D(off)}$	Turn-Off Delay Time				35		ns
$t_f$	Turn-Off Fall Time				25.5		ns
$t_{rr}$	Body Diode Reverse Recovery Time	$I_F=-3.5\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		25.8	35	ns	
$Q_{rr}$	Body Diode Reverse Recovery Charge	$I_F=-3.5\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		28.8		nC	

A: The value of  $R_{\theta JA}$  is measured with the device mounted on 1in<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  $t_s \leq 10\text{s}$  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

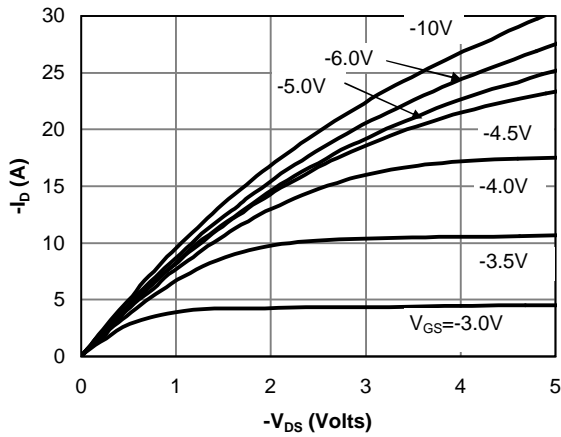


Fig 1: On-Region Characteristics

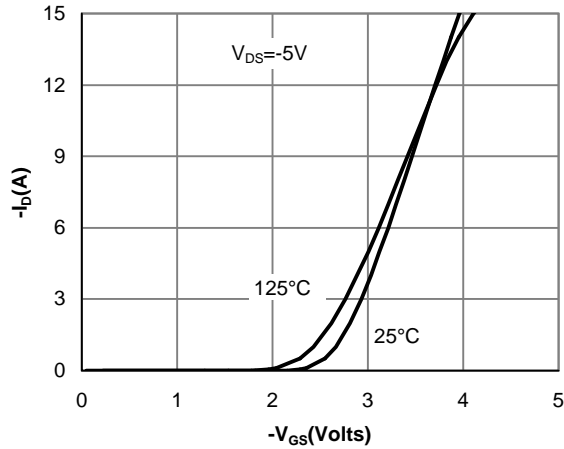


Figure 2: Transfer Characteristics

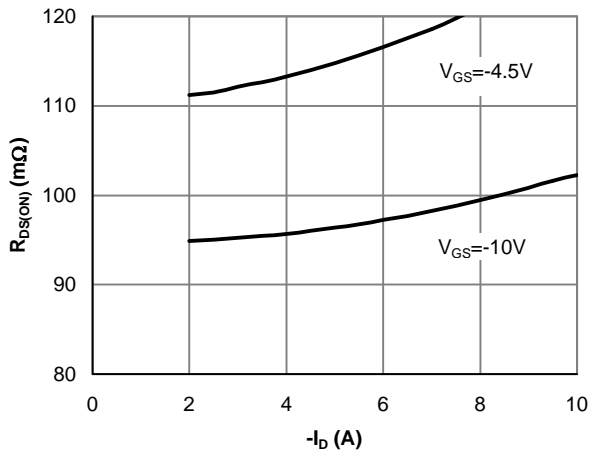


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

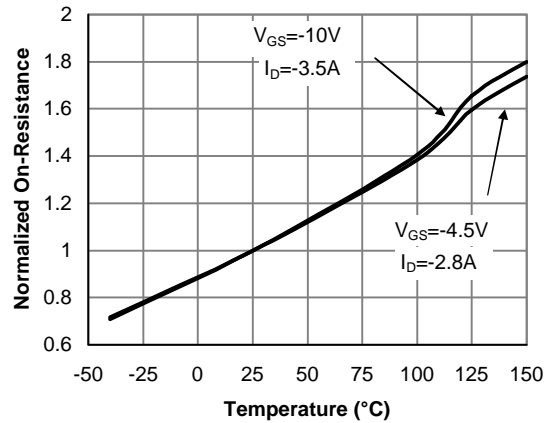


Figure 4: On-Resistance vs. Junction Temperature

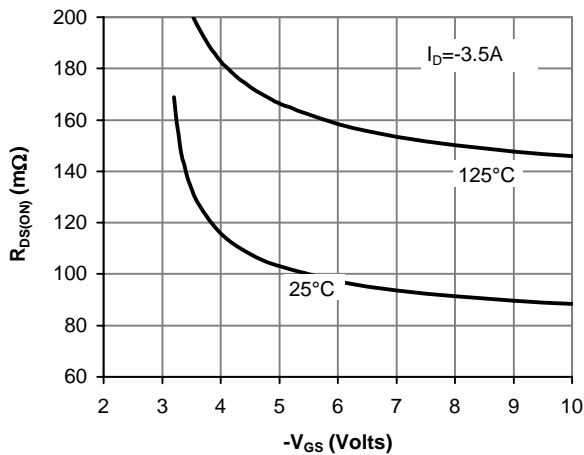


Figure 5: On-Resistance vs. Gate-Source Voltage

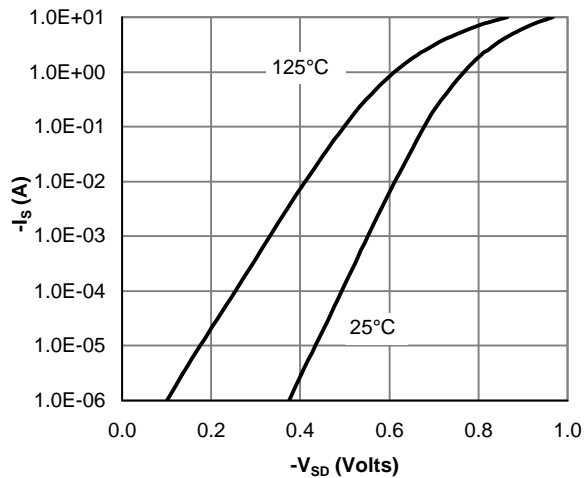


Figure 6: Body-Diode Characteristics

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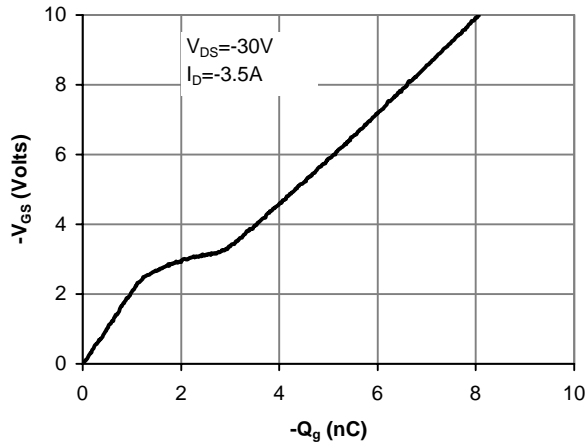


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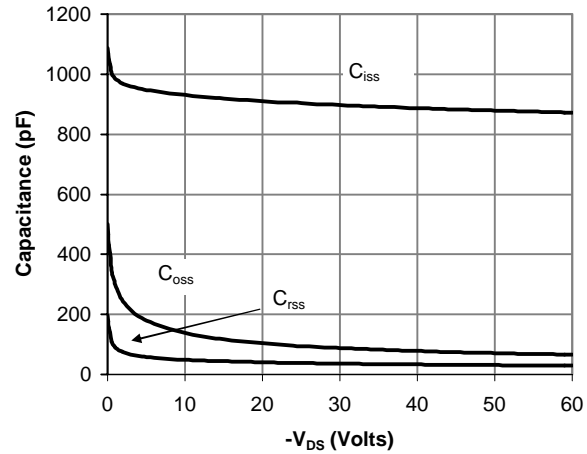


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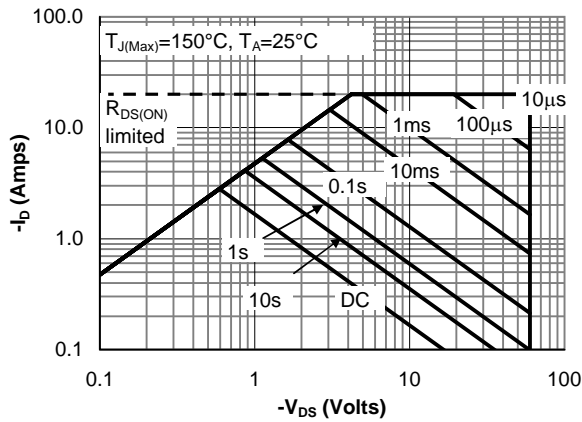


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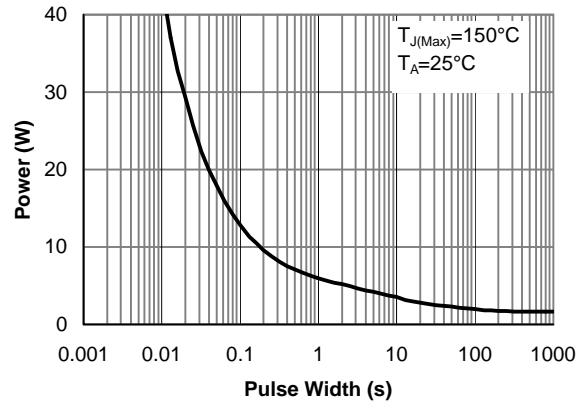


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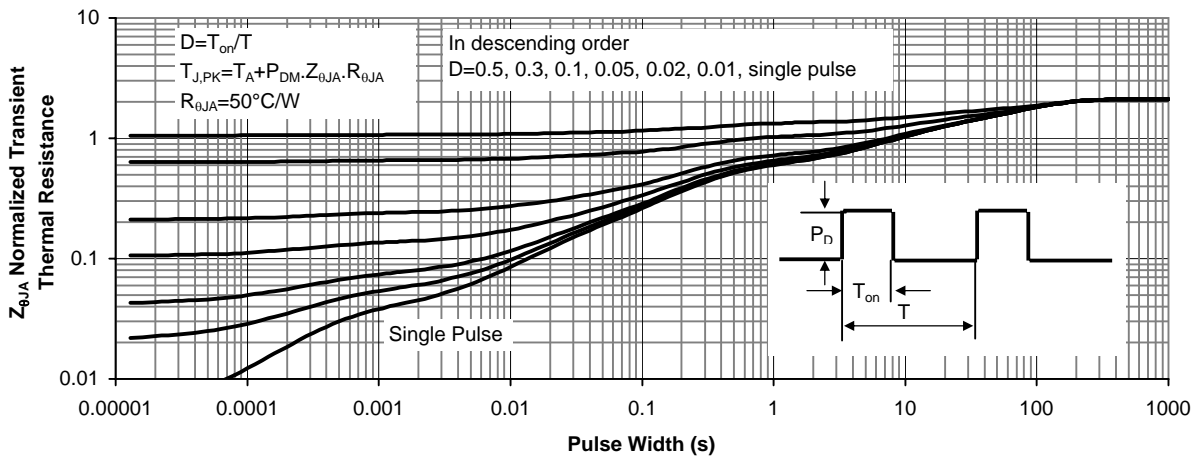


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