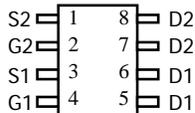## ALPHA & OMEGA SEMICONDUCTOR

Pb Free

AOP609
Complementary Enhancement Mode Field Effect Transistor
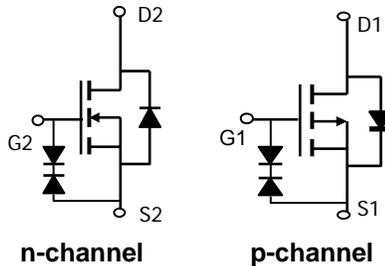
General Description

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)

$R_{DS(ON)}$ $R_{DS(ON)}$

< 60mΩ (V_{GS}=10V)   < 115mΩ (V_{GS} =-10V)

< 75mΩ (V_{GS}=4.5V)   < 140mΩ (V_{GS} =-4.5V)

ESD Rating: 1500V HBM   3000V HMB

S2	1	8	D2
G2	2	7	D2
S1	3	6	D1
G1	4	5	D1

PDIP-8

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}	60	-60	V
Gate-Source Voltage		V_{GS}	±20	±20	V
Continuous Drain Current [A]	T_A=25°C		4.7	-3.5	
	T_A=70°C	I_D	3.8	-2.9	A
Pulsed Drain Current [B]		I_{DM}	20	-20	
Power Dissipation	T_A=25°C	P_D	2.5	2.5	W
	T_A=70°C		1.6	1.6	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	-55 to 150	°C

Thermal Characteristics: n-channel and p-channel

Parameter		Symbol	Device	Typ	Max	Units
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{θJA}$	n-ch	37	50	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		n-ch	74	90	°C/W
Maximum Junction-to-Lead [C]	Steady-State	$R_{θJL}$	n-ch	28	40	°C/W
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{θJA}$	p-ch	35	50	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		p-ch	73	90	°C/W
Maximum Junction-to-Lead [C]	Steady-State	$R_{θJL}$	p-ch	32	40	°C/W

Alpha & Omega Semiconductor, Ltd.

AOP609

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

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1in² FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The value in any 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 impedance from junction to lead $R_{\theta JL}$ and lead to ambient.
D. The static characteristics in Figures 1 to 6 are obtained using 80µs pulses, duty cycle 0.5% max.
E. These tests are performed with the device mounted on 1 in² FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The SOA curve provides a single pulse rating.
Rev 1 : December 2005

Alpha & Omega Semiconductor, Ltd.

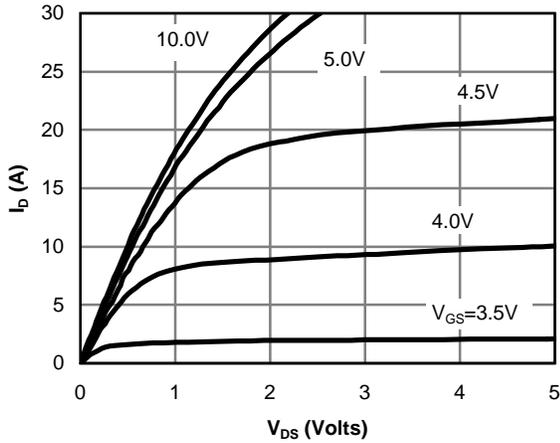### TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL
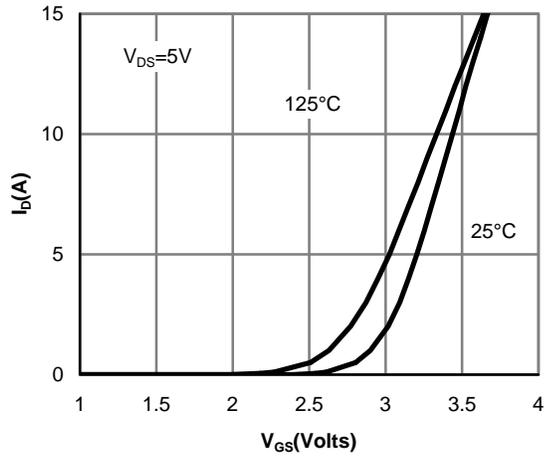
Fig 1: On-Region Characteristics

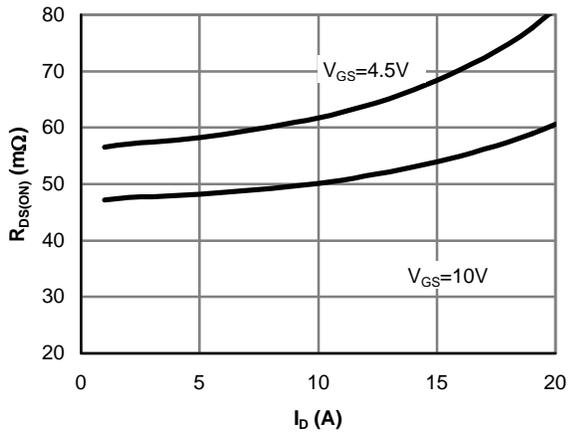**Figure 2: Transfer Characteristics**

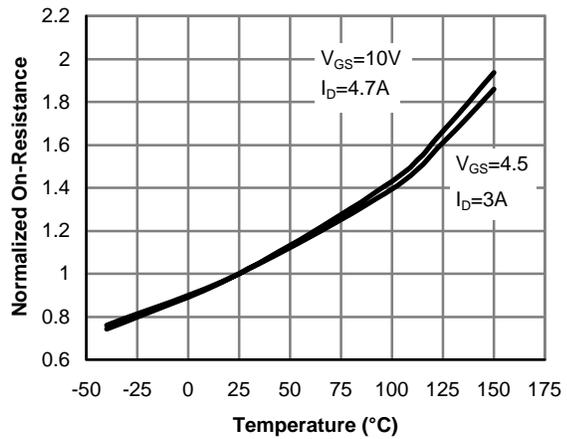**Figure 3: On-Resistance vs. Drain Current and Gate Voltage**
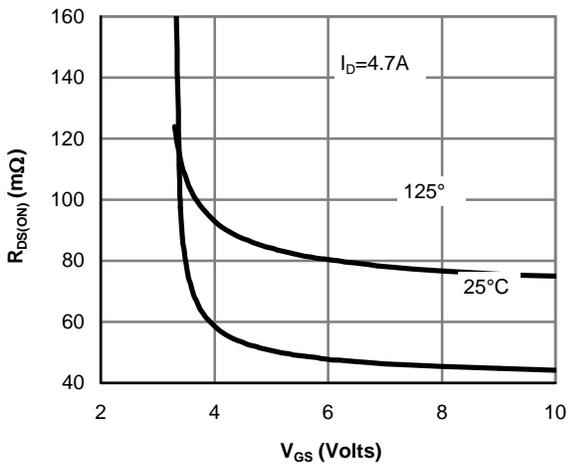
Figure 4: On-Resistance vs. Junction Temperature

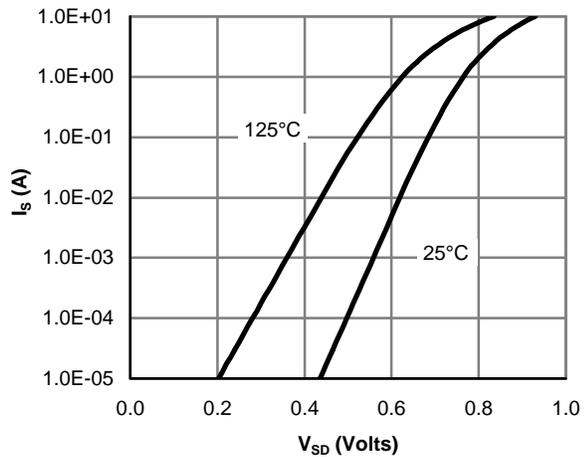**Figure 5: On-Resistance vs. Gate-Source Voltage**

Figure 6: Body-Diode Characteristics

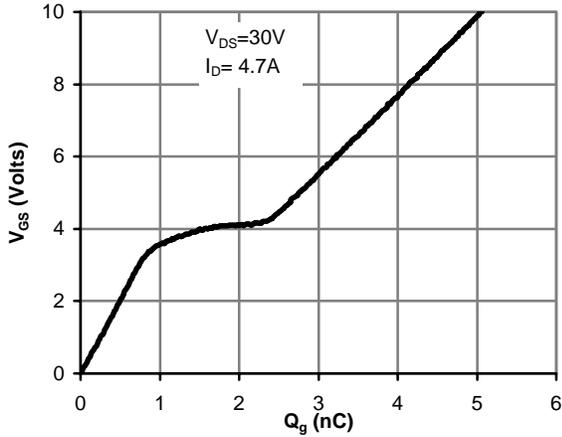## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL
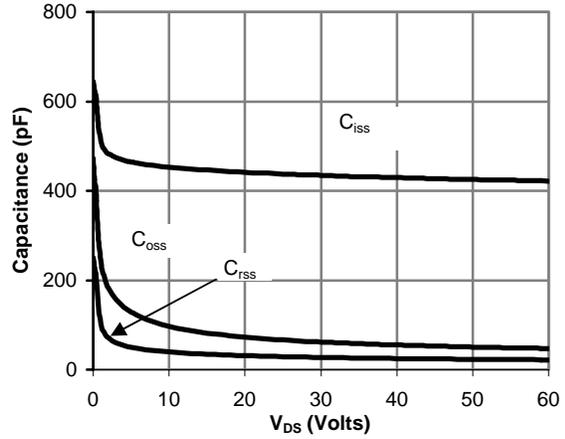

Figure 7: Gate-Charge Characteristics

$V_{DS}=30V$
$I_D=4.7A$

Figure 8: Capacitance Characteristics

C_{iss}
C_{oss}
C_{rss}

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

$R_{DS(ON)}$ limited
$T_{J(Max)}=150°C$
$T_A=25°C$
100µs 10µs
10ms 1ms
0.1s
10s 1s
DC

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

$T_{J(Max)}=150°C$
$T_A=25°C$

Figure 11: Normalized Maximum Transient Thermal Impedance

$D=T_{on}/T$
$T_{J,PK}=T_A+P_{DM} \cdot Z_{\theta JA} \cdot R_{\theta JA}$
$R_{\theta JA}=50°C/W$
In descending order
D=0.5, 0.3, 0.1, 0.05, 0.02, 0.01, single pulse
Single Pulse
P_D
T_{on}
T

Alpha & Omega Semiconductor, Ltd.

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

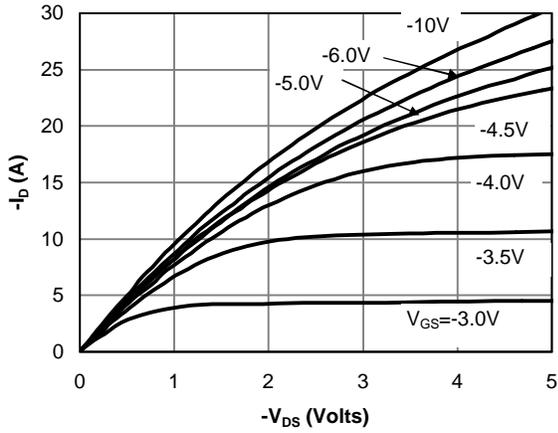## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL
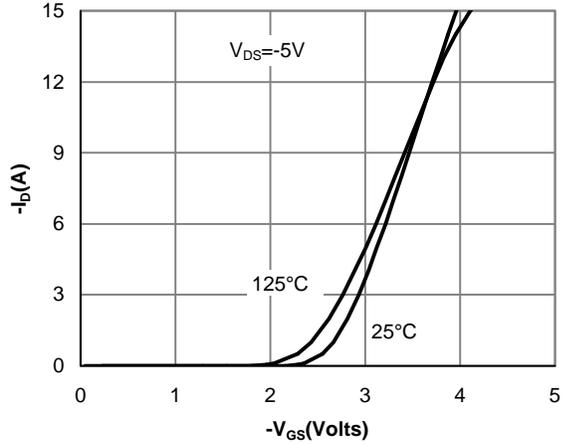
Fig 1: On-Region Characteristics
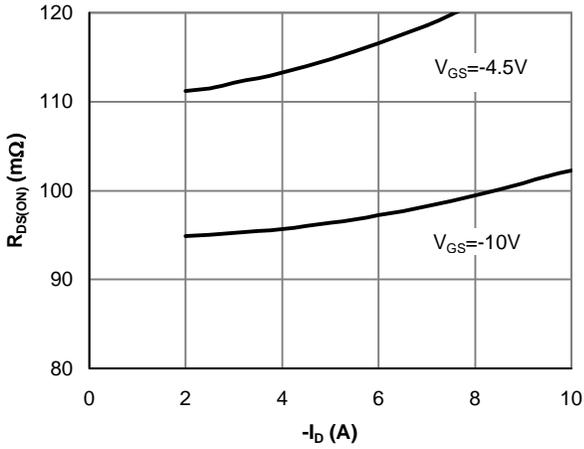
Figure 2: Transfer Characteristics

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

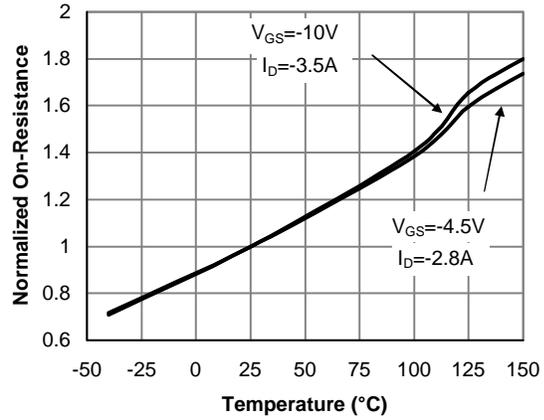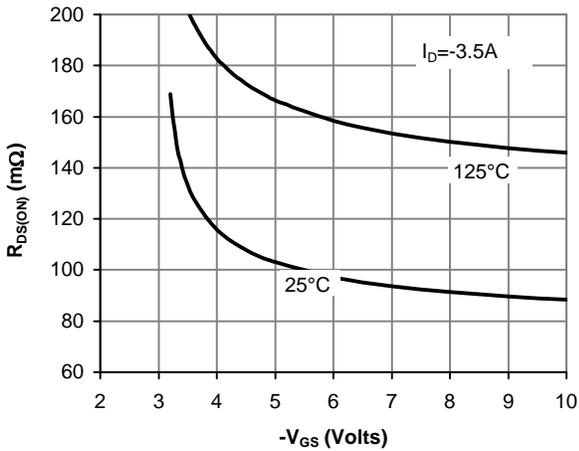**Figure 4: On-Resistance vs. Junction Temperature**
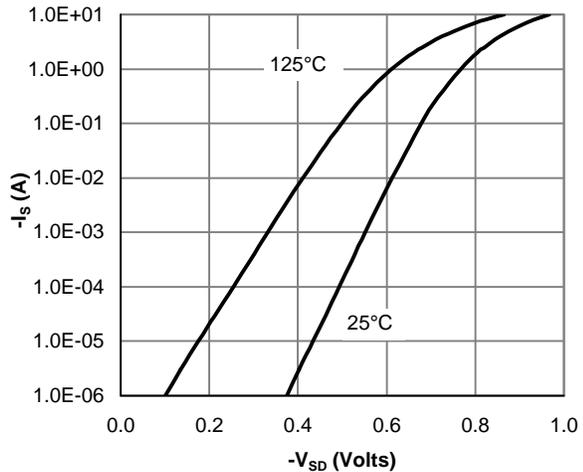
Figure 5: On-Resistance vs. Gate-Source Voltage

Figure 6: Body-Diode Characteristics

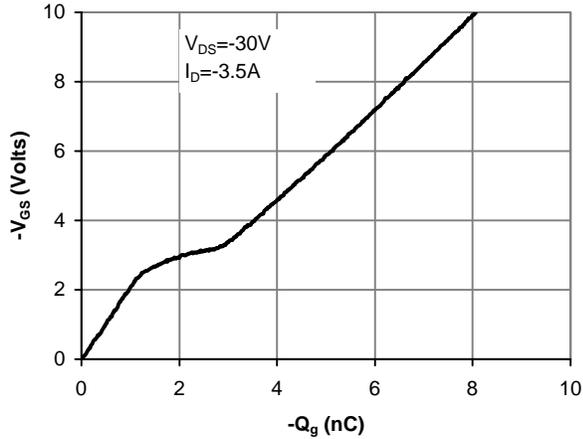## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL
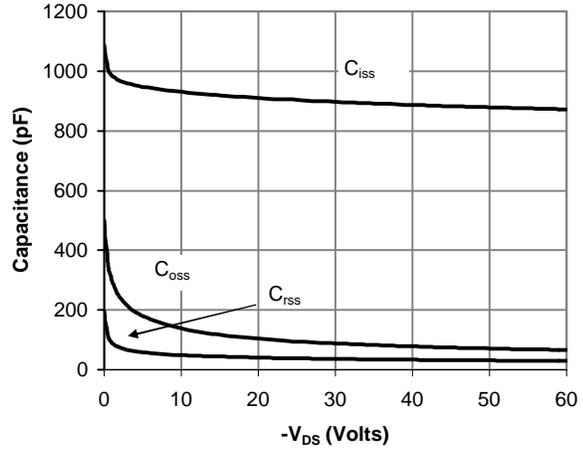
Figure 7: Gate-Charge Characteristics
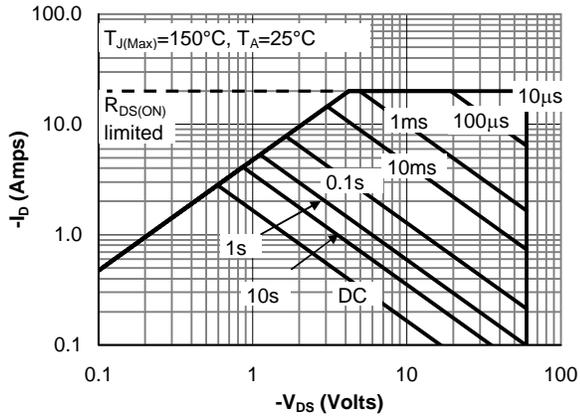
Figure 8: Capacitance Characteristics

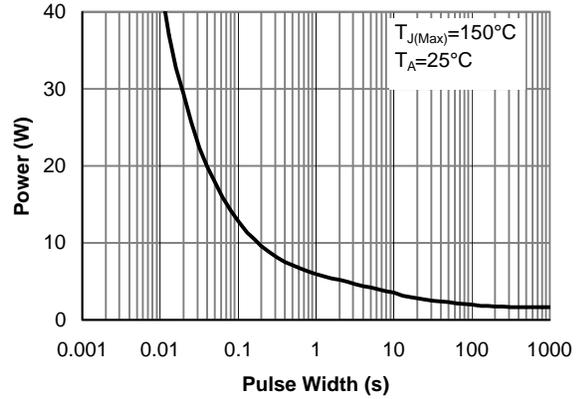Figure 9: Maximum Forward Biased Safe Operating Area (Note E)
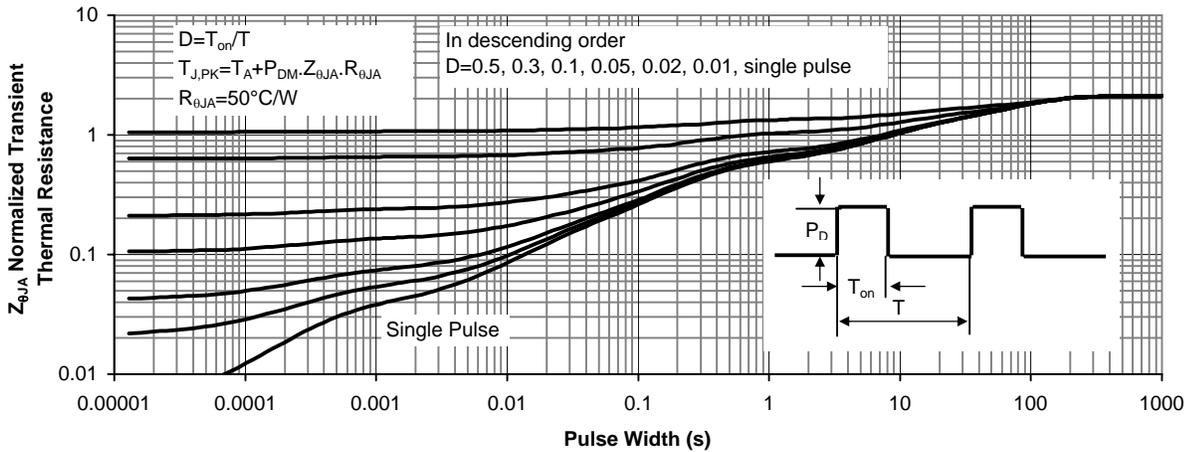
Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

Figure 11: Normalized Maximum Transient Thermal Impedance