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ALPHA & OMEGA SEMICONDUCTOR, INC.

July 2003

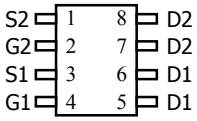
AO4609
Complementary Enhancement Mode Field Effect Transistor

General Description

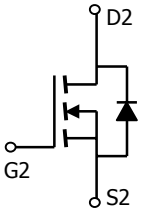
The AO4609 uses advanced trench technology MOSFETs to provide excellent $R_{DS(ON)}$ and low gate charge. The complementary MOSFETs may be used to form a level shifted high side switch, and for a host of other applications.

Features

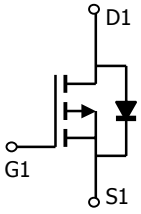
n-channel	p-channel
V_{DS} (V) = 30V	-30V
I_D = 8.5A	-3A
$R_{DS(ON)}$	$R_{DS(ON)}$
< 18mΩ (V_{GS}=10V)	< 130mΩ (V_{GS} = 10V)
< 28mΩ (V_{GS}=4.5V)	< 180mΩ (V_{GS} = 4.5V)
	< 260mΩ (V_{GS} = 2.5V)



SOIC-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}	30	-30	V
Gate-Source Voltage		V_{GS}	±20	±12	V
Continuous Drain Current [A]	T_A=25°C	I_D	8.5	-3	A
	T_A=70°C		6.6	-2.4	
Pulsed Drain Current [B]		I_{DM}	40	-6	
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

Thermal Characteristics: n-channel 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	40	°C/W
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	p-ch	56	62.5	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		p-ch	81	110	°C/W
Maximum Junction-to-Lead [C]	Steady-State	$R_{\theta JL}$	p-ch	40	48	°C/W

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	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	1.8	3	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=8.5A		15.5	18	mΩ
		T_J=125°C		22.3	27	
		V_{GS}=4.5V, I_D=6A		23	28	mΩ
g_{FS}	Forward Transconductance	V_{DS}=5V, I_D=8.5A		23		S
V_{SD}	Diode Forward Voltage	I_S=1A,V_{GS}=0V		0.75	1	V
I_S	Maximum Body-Diode Continuous Current				3	A
DYNAMIC PARAMETERS						
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=15V, f=1MHz		1040		pF
C_{oss}	Output Capacitance			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 Reverse Recovery Time	I_F=8.5A, dI/dt=100A/μs		16.7		ns
Q_{rr}	Body Diode Reverse Recovery Charge	I_F=8.5A, dI/dt=100A/μs		6.7		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 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.

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}=±12V			±100	nA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS} I_D=-250µA	-0.6	-1	-1.4	V
$I_{D(ON)}$	On state drain current	V_{GS}=-4.5V, V_{DS}=-5V	-10			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS}=-10V, I_D=-3A		102	130	mΩ
		T_J=125°C		154	200	
		V_{GS}=-4.5V, I_D=-2A		128	180	mΩ
		V_{GS}=-2.5V, I_D=-1A		187	260	mΩ
g_{FS}	Forward Transconductance	V_{DS}=-5V, I_D=-3A	3	4.5		S
V_{SD}	Diode Forward Voltage	I_S=-1A,V_{GS}=0V		-0.85	-1	V
I_S	Maximum Body-Diode Continuous Current				-2	A
DYNAMIC PARAMETERS						
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=-15V, f=1MHz		409		pF
C_{oss}	Output Capacitance			55		pF
C_{rss}	Reverse Transfer Capacitance			42		pF
R_g	Gate resistance	V_{GS}=0V, V_{DS}=0V, f=1MHz		12		Ω
SWITCHING PARAMETERS						
Q_g	Total Gate Charge	V_{GS}=-4.5V, V_{DS}=-15V, I_D=-3A		4.4		nC
Q_{gs}	Gate Source Charge			0.8		nC
Q_{gd}	Gate Drain Charge			1.32		nC
$t_{D(on)}$	Turn-On DelayTime	V_{GS}=-10V, V_{DS}=-15V, R_L=5Ω, R_{GEN}=3Ω		5.3		ns
t_r	Turn-On Rise Time			4.4		ns
$t_{D(off)}$	Turn-Off DelayTime			31.5		ns
t_f	Turn-Off Fall Time			8		ns
t_{rr}	Body Diode Reverse Recovery Time	I_F=-3A, dI/dt=100A/µs		15.8		ns
Q_{rr}	Body Diode Reverse Recovery Charge	I_F=-3A, dI/dt=100A/µs		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 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

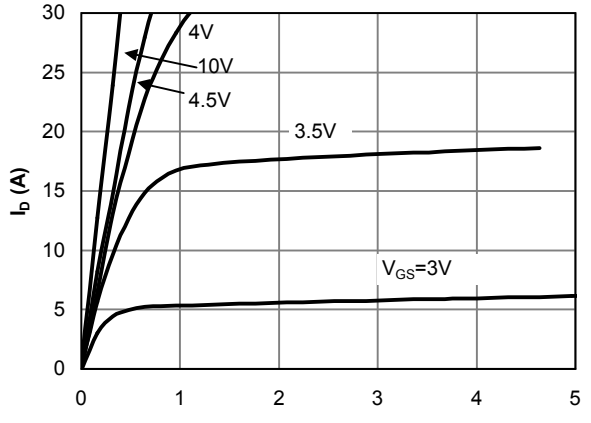


Fig 1: On-Region Characteristics

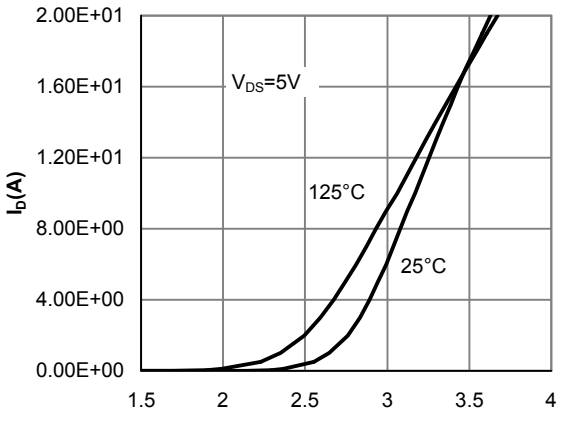


Figure 2: Transfer Characteristics

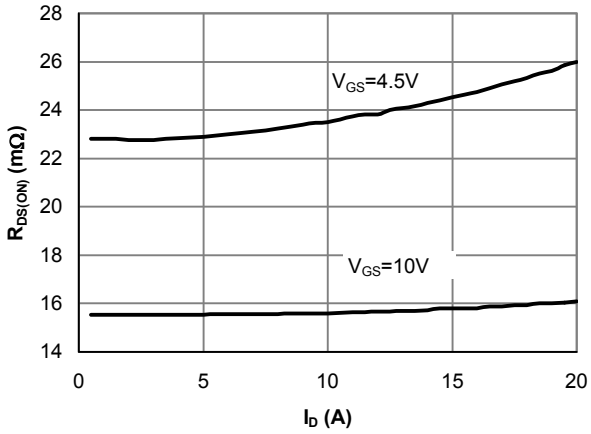


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

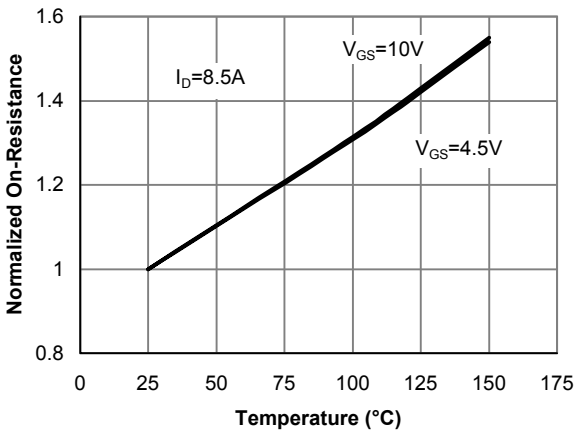


Figure 4: On-Resistance vs. Junction Temperature

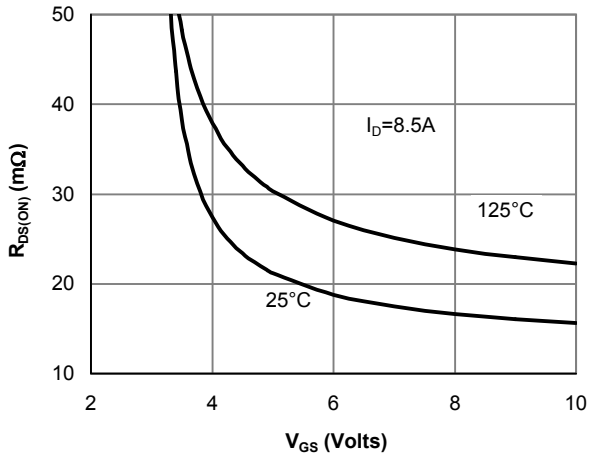


Figure 5: On-Resistance vs. Gate-Source Voltage

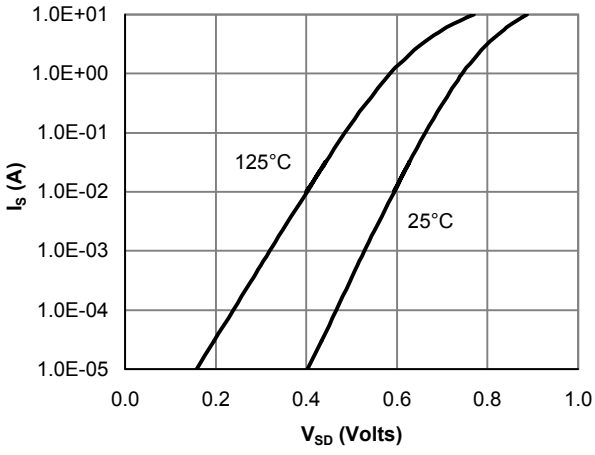


Figure 6: Body-Diode Characteristics

N-CHANNEL: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

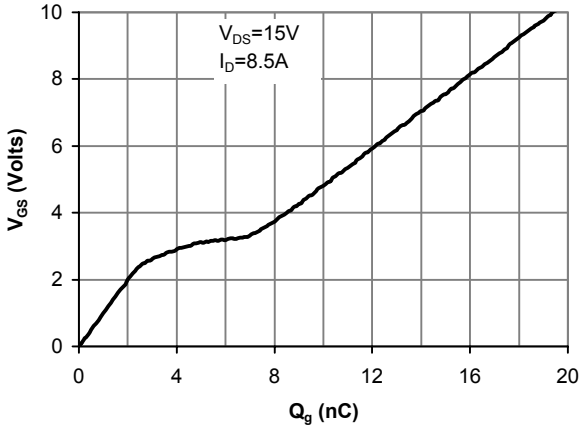


Figure 7: Gate-Charge Characteristics

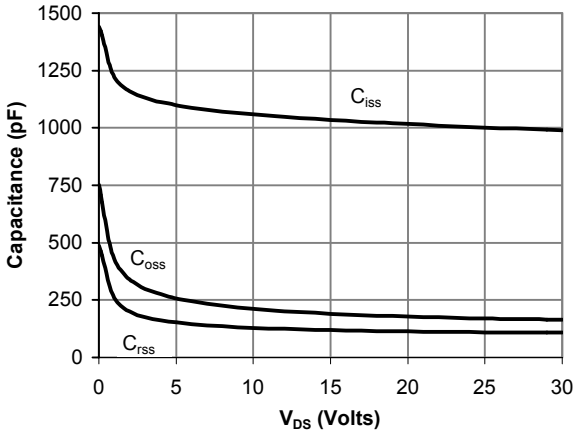


Figure 8: Capacitance Characteristics

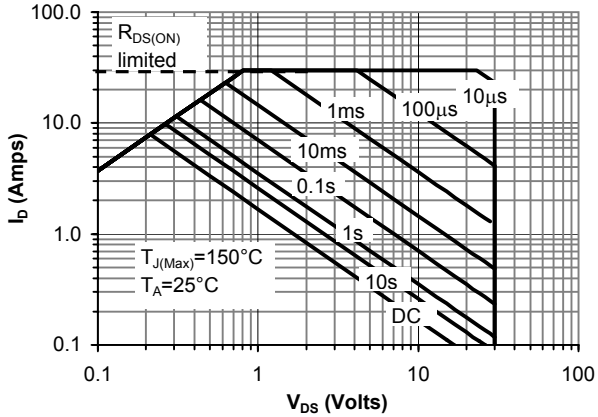


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

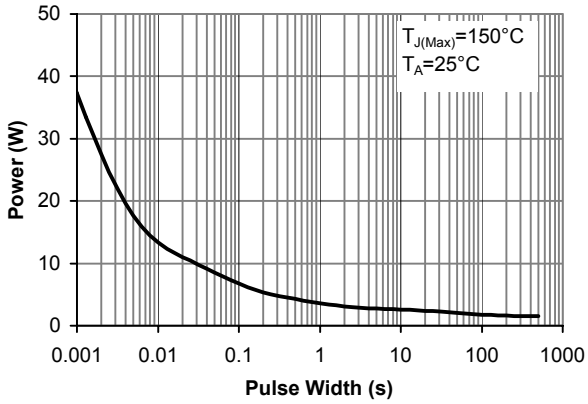


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

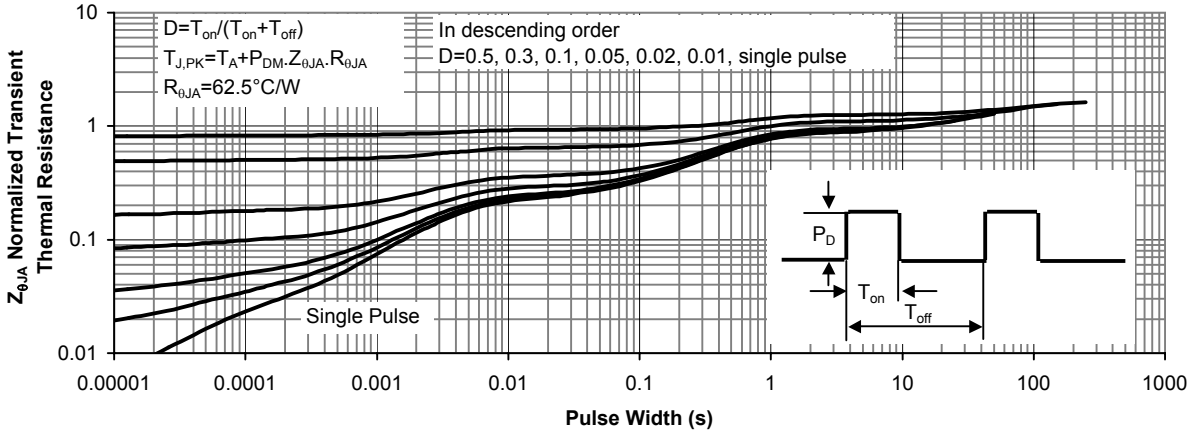


Figure 11: Normalized Maximum Transient Thermal Impedance

P-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

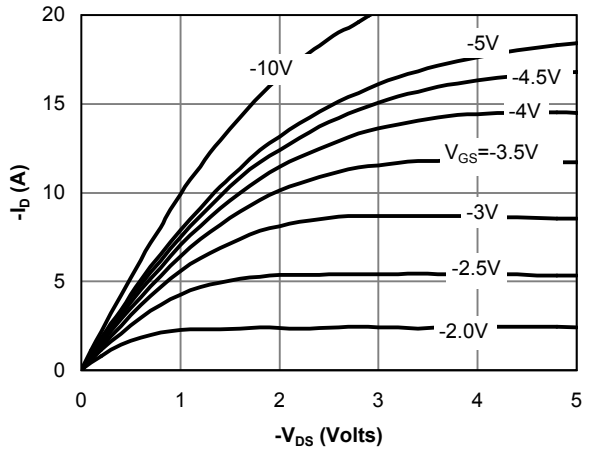


Fig 1: On-Region Characteristics

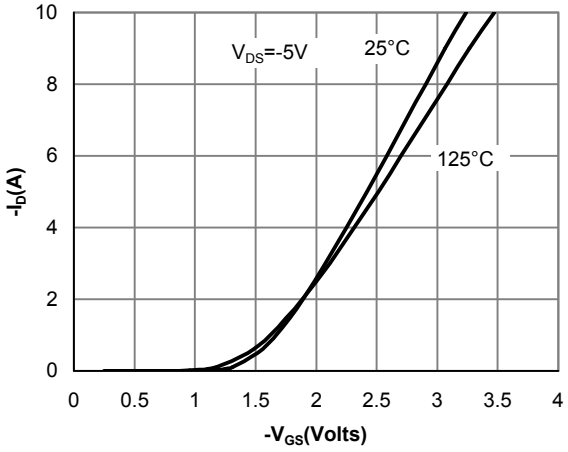


Figure 2: Transfer Characteristics

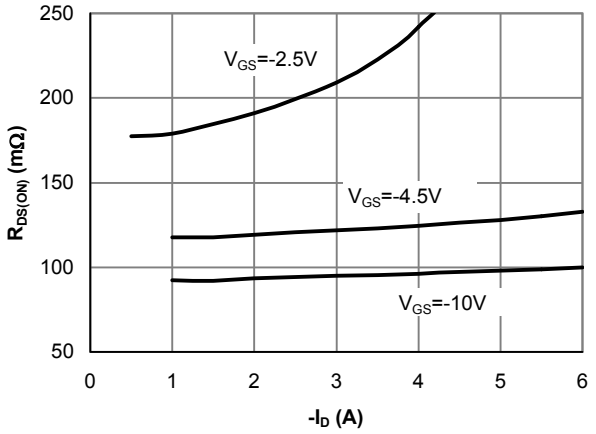


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

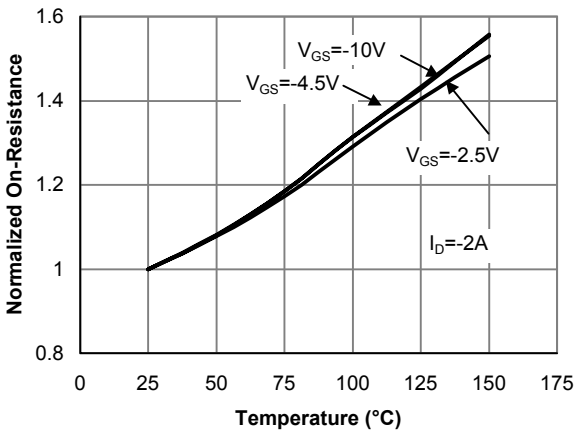


Figure 4: On-Resistance vs. Junction Temperature

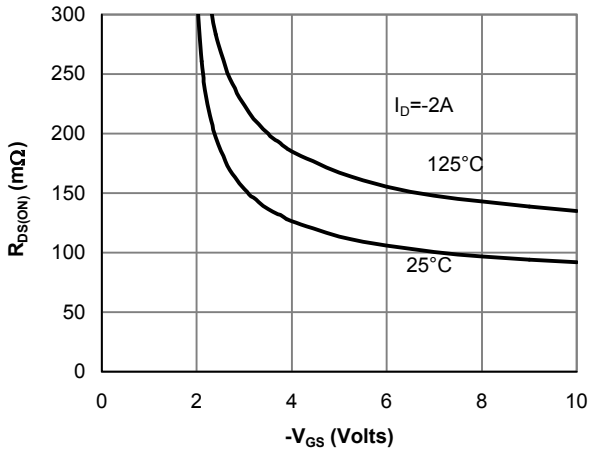


Figure 5: On-Resistance vs. Gate-Source Voltage

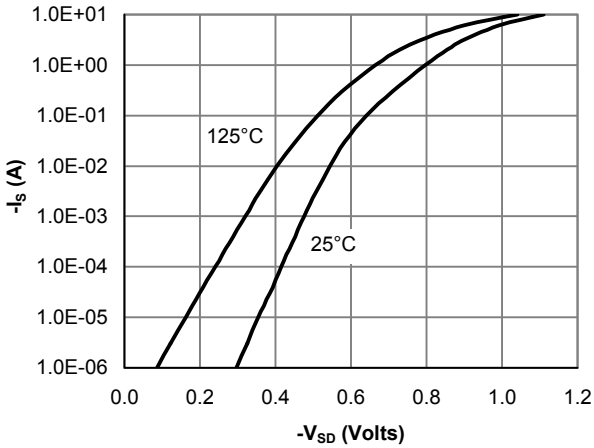


Figure 6: Body-Diode Characteristics

P-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

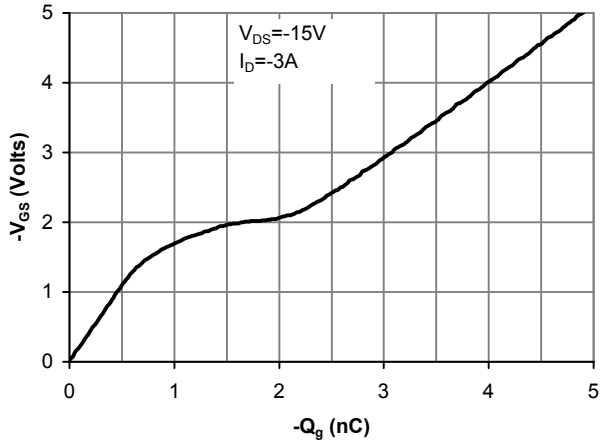


Figure 7: Gate-Charge Characteristics

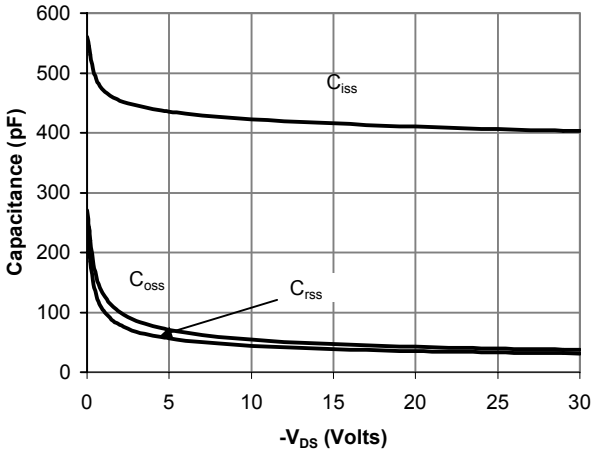


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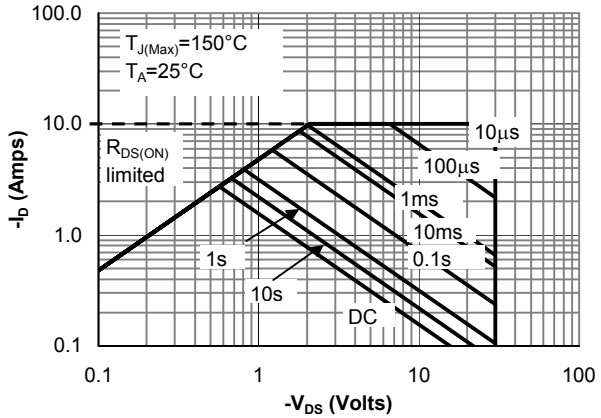


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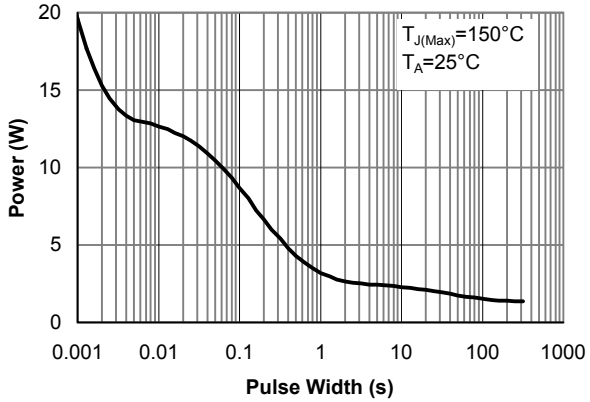


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

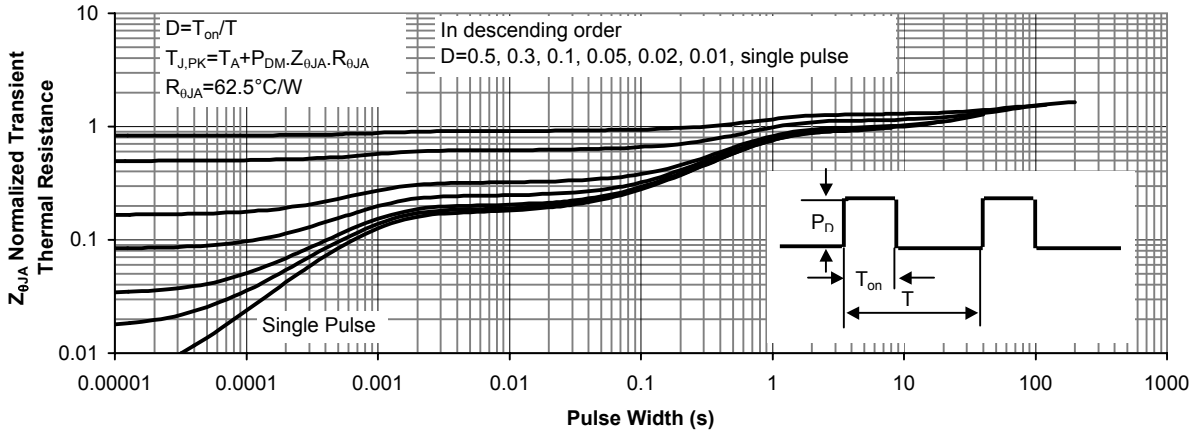
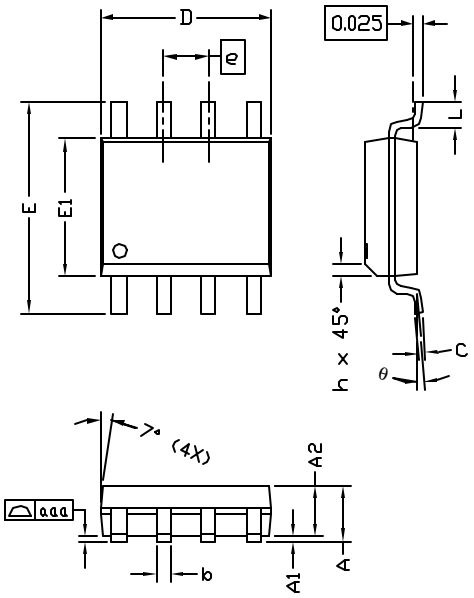


Figure 11: Normalized Maximum Transient Thermal Impedance

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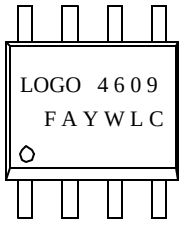
SO-8 Package Data



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.45	1.50	1.55	0.057	0.059	0.061
A1	0.00	——	0.10	0.000	——	0.004
A2	——	1.45	——	——	0.057	——
b	0.33	——	0.51	0.013	——	0.020
c	0.19	——	0.25	0.007	——	0.010
D	4.80	——	5.00	0.189	——	0.197
E1	3.80	——	4.00	0.150	——	0.157
e	1.27 BSC			0.050 BSC		
E	5.80	——	6.20	0.228	——	0.244
h	0.25	——	0.50	0.010	——	0.020
L	0.40	——	1.27	0.016	——	0.050
aaa	——	——	0.10	——	——	0.004
θ	0°	——	8°	0°	——	8°

NOTE:
1. LEAD FINISH: 150 MICROINCHES (3.8 um) MIN. THICKNESS OF Tin/Lead (SOLDER) PLATED ON LEAD
2. TOLERANCE ±0.10 mm (4 mil) UNLESS OTHERWISE SPECIFIED
3. COPLANARITY : 0.10 mm
4. DIMENSION L IS MEASURED IN GAGE PLANE

PACKAGE MARKING DESCRIPTION

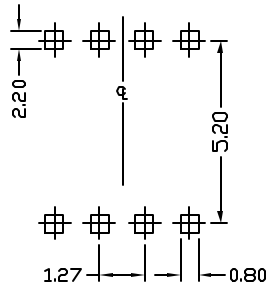


NOTE:
LOGO - AOS LOGO
4609 - PART NUMBER CODE.
F - FAB LOCATION
A - ASSEMBLY LOCATION
Y - YEAR CODE
W - WEEK CODE.
L C - ASSEMBLY LOT CODE

SO-8 PART NO. CODE

PART NO.	CODE
AO4609	4609

RECOMMENDED LAND PATTERN

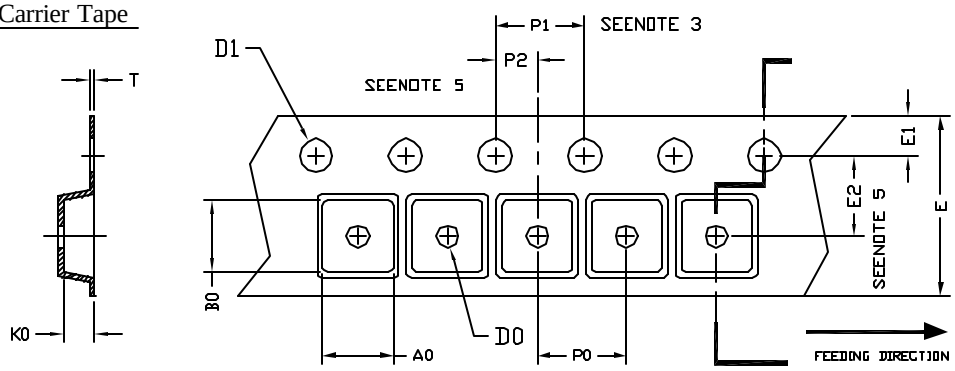


UNIT: mm

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SEMICONDUCTOR, INC.

SO-8 Tape and Reel Data

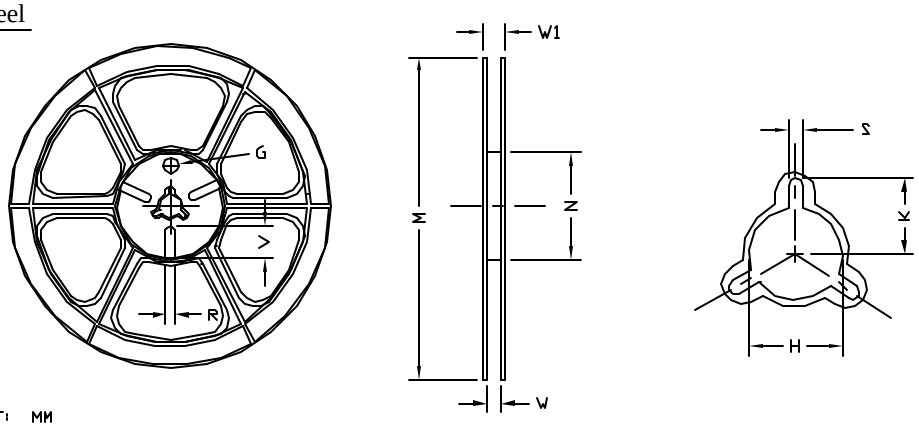
SO-8 Carrier Tape



UNIT: MM

PACKAGE	A0	B0	K0	D0	D1	E	E1	E2	P0	P1	P2	T
SO-8 (12 mm)	6.40 ±0.10	5.20 ±0.10	2.10 ±0.10	1.60 ±0.10	1.50 +0.10	12.00 ±0.30	1.75 ±0.10	5.50 ±0.05	8.00 ±0.10	4.00 ±0.10	2.00 ±0.05	0.25 ±0.05

SO-8 Reel

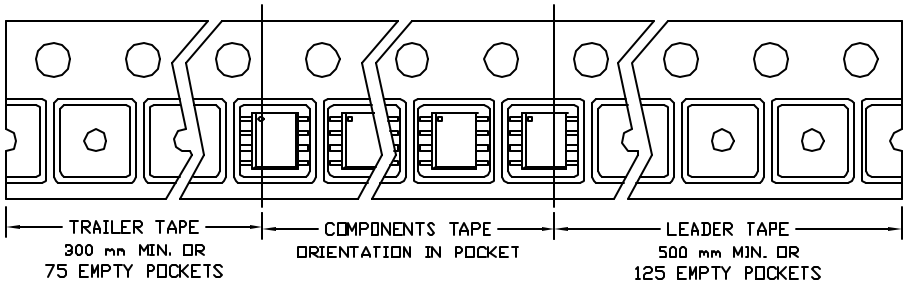


UNIT: MM

TAPE SIZE	REEL SIZE	M	N	W	W1	H	K	S	G	R	V
12 mm	ø330	ø330.00 ±0.50	ø97.00 ±0.10	13.00 ±0.30	17.40 ±1.00	ø13.00 +0.50 -0.20	10.60	2.00 ±0.50	---	---	---

SO-8 Tape

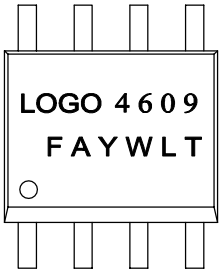
Leader / Trailer & Orientation



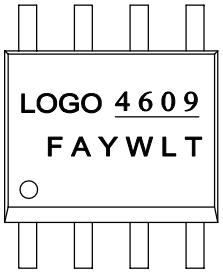
Document No.	PD-00064
Version	rev C
Title	AO4609 Marking Description

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SO-8 PACKAGE MARKING DESCRIPTION



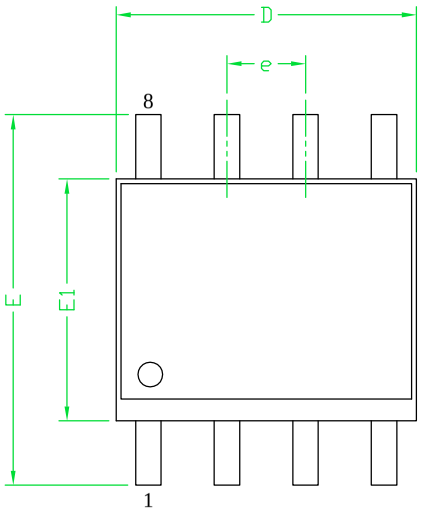
Standard product

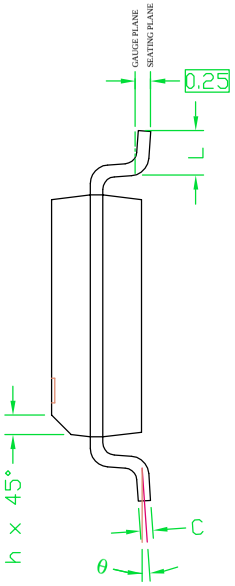


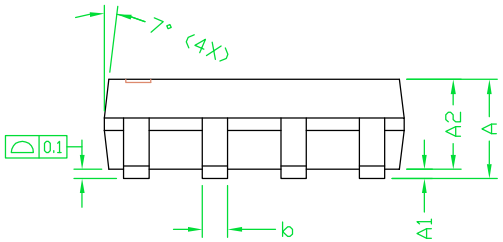
Green product

NOTE:
LOGO - AOS LOGO
4609 - PART NUMBER CODE.
F&A - FOUNDRY AND ASSEMBLY LOCATION
Y - YEAR CODE
W - WEEK CODE.
L T - ASSEMBLY LOT CODE

PART NO.	DESCRIPTION	CODE
AO4609	Standard product	4609
AO4609L	Green product	4609



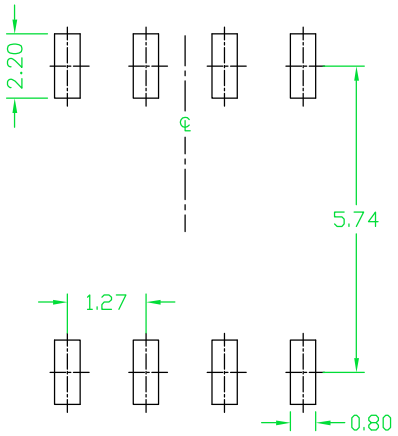




NOTE
1. ALL DIMENSIONS ARE IN MILLMETERS.
2.DIMENSIONS ARE INCLUSIVE OF PLATING.
3.PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS.
4. DIMENSION L IS MEASURED IN GAUGE PLANE.
5. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.65	1.75	0.053	0.065	0.069
A1	0.10	——	0.25	0.004	——	0.010
A2	1.25	1.50	1.65	0.049	0.059	0.065
b	0.31	——	0.51	0.012	——	0.020
c	0.17	——	0.25	0.007	——	0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E1	3.80	3.90	4.00	0.150	0.154	0.157
e	1.27 BSC			0.050 BSC		
E	5.80	6.00	6.20	0.228	0.236	0.244
h	0.25	——	0.50	0.010	——	0.020
L	0.40	——	1.27	0.016	——	0.050
θ	0°	——	8°	0°	——	8°

RECOMMENDED LAND PATTERN



UNIT: mm

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMAL ANGULAR
X.X ± ±
X.XX ±
X.XXX ±
INTERPRET DIM AND TOL PER ASME Y14.5M – 1994
PRINTING IS SCALED TO FIT DO NOT SCALE DRAWING

THIRD ANGLE PROJECTION

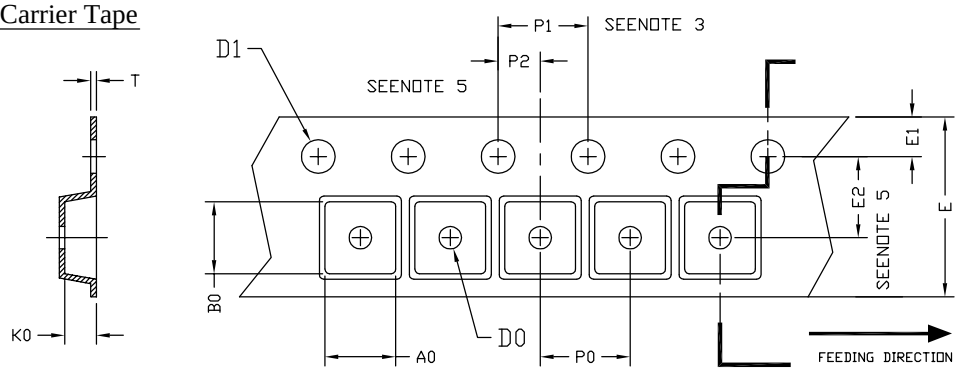
ALPHA & OMEGA SEMICONDUCTOR, LTD.

Document No.	PD–00004
Version	rev D
Title	SO–8 PACKAGE OUTLINE

ALPHA & OMEGA
SEMICONDUCTOR, LTD.

SO-8 Tape and Reel Data

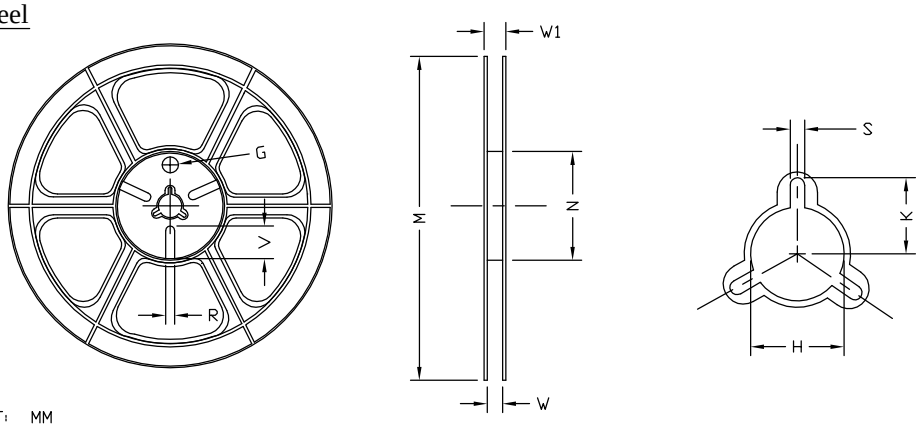
SO-8 Carrier Tape



UNIT: MM

PACKAGE	A0	B0	K0	D0	D1	E	E1	E2	P0	P1	P2	T
SO-8 (12 mm)	6.40 ±0.10	5.20 ±0.10	2.10 ±0.10	1.60 ±0.10	1.50 +0.10	12.00 ±0.30	1.75 ±0.10	5.50 ±0.05	8.00 ±0.10	4.00 ±0.10	2.00 ±0.05	0.25 ±0.05

SO-8 Reel



UNIT: MM

TAPE SIZE	REEL SIZE	M	N	W	W1	H	K	S	G	R	V
12 mm	ø330	ø330.00 ±0.50	ø97.00 ±0.10	13.00 ±0.30	17.40 ±1.00	ø13.00 +0.50 −0.20	10.60	2.00 ±0.50	---	---	---

SO-8 Tape

Leader / Trailer & Orientation

