



# **AOS Semiconductor Product Reliability Report**

**AO4609/AO4609L, rev A**

**Plastic Encapsulated Device**

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This AOS product reliability report summarizes the qualification result for AO4609. Accelerated environmental tests are performed on a specific sample size, and then followed by electrical test at end point. Review of final electrical test result confirms that AO4609 passes AOS quality and reliability requirements. The released product will be categorized by the process family and be monitored on a quarterly basis for continuously improving the product quality.

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### I. Product 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. Standard Product AO4609 is Pb-free (meets ROHS & Sony 259 specifications). AO4609L is a Green Product ordering option. AO4609 and AO4609L are electrically identical.

Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted					
Parameter		Symbol	Max n-channel	Max p-channel	Units
Drain-Source Voltage		$V_{DS}$	30	-30	V
Gate-Source Voltage		$V_{GS}$	$\pm 20$	$\pm 12$	V
Continuous Drain Current	$T_A=25^\circ\text{C}$	$I_D$	8.5	-3	A
	$T_A=70^\circ\text{C}$		6.6	-2.4	
Pulsed Drain Current		$I_{DM}$	40	-6	
Power Dissipation	$T_A=25^\circ\text{C}$	$P_D$	2	2	W
	$T_A=70^\circ\text{C}$		1.28	1.28	
Junction and Storage Temperature Range		$T_J, T_{STG}$	-55 to 150	-55 to 150	$^\circ\text{C}$

Thermal Characteristics : n-channel, Schottky and p-channel						
Parameter		Symbol	Device	Typ	Max	Units
Maximum Junction-to-Ambient	$t \leq 10\text{s}$	$R_{\theta JA}$	n-ch	48	62.5	$^\circ\text{C/W}$
	Steady-State		n-ch	74	110	
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	n-ch	35	40	
Maximum Junction-to-Ambient	$t \leq 10\text{s}$	$R_{\theta JA}$	p-ch	56	62.5	
	Steady-State		p-ch	81	110	
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	p-ch	40	48	

## II. Die / Package Information:

	<b>AO4609</b>	<b>AO4609L (Green Compound)</b>
<b>Process</b>	Standard sub-micron low voltage N/P channel process	Standard sub-micron low voltage N/P channel process
<b>Package Type</b>	8 lead SOIC	8 lead SOIC
<b>Lead Frame</b>	Copper with Solder Plate	Copper with Solder Plate
<b>Die Attach</b>	Silver epoxy	Silver epoxy
<b>Bond wire</b>	2 mils Au wire	2 mils Au wire
<b>Mold Material</b>	Epoxy resin with silica filler	Epoxy resin with silica filler
<b>Filler % (Spherical/Flake)</b>	90/10	100/0
<b>Flammability Rating</b>	UL-94 V-0	UL-94 V-0
<b>Backside Metallization</b>	Ti / Ni / Ag	Ti / Ni / Ag
<b>Moisture Level</b>	Up to Level 1 *	Up to Level 1*

**Note** \* based on info provided by assembler and mold compound supplier

## III. Result of Reliability Stress for AO4609 (Standard) & AO4609L (Green)

Test Item	Test Condition	Time Point	Lot Attribution	Total Sample size	Number of Failures
Solder Reflow Precondition	Standard: 1hr PCT+3 cycle reflow @260°C Green: 168hr 85°C /85%RH+3 cycle reflow @260°C	0hr	Standard: 48 lots Green: 16 lots	9405 pcs	0
HTGB	Temp = 150°C, Vgs=100% of Vgsmx	168 / 500 hrs  1000 hrs	2 lots  (Note A*)	164 pcs  77+5 pcs / lot	0
HTRB	Temp = 150°C, Vds=80% of Vdsmax	168 / 500 hrs  1000 hrs	2 lots  (Note A*)	164 pcs  77+5 pcs / lot	0
HAST	130 +/- 2°C, 85%RH, 33.3 psi, Vgs = 80% of Vgs max	100 hrs	Standard: 30 lots Green: 14 lots  (Note B**)	2420 pcs  50+5 pcs / lot	0
Pressure Pot	121°C, 15+/-1 PSIG, RH=100%	96 hrs	Standard: 48 lots Green: 16 lots  (Note B**)	3520 pcs  50+5 pcs / lot	0
Temperature Cycle	-65 to 150°C, air to air, 0.5hr per cycle	250 / 500 cycles	Standard: 48 lots Green: 15 lots  (Note B**)	3465 pcs  50+5 pcs / lot	0
DPA	Internal Vision Cross-section X-ray	NA	5 5 5	5 5 5	0

<b>CSAM</b>		<b>NA</b>	<b>5</b>	<b>5</b>	<b>0</b>
<b>Bond Integrity</b>	Room Temp 150°c bake 150°c bake	0hr 250hr 500hr	40 40 40	40 wires 40 wires 40 wires	0
<b>Solderability</b>	230°c	5 sec	15	15 leads	0

**Note A:** The HTGB and HTRB reliability data presents total of available AO4609 and AO4609L burn-in data up to the published date.

**Note B:** The pressure pot, temperature cycle and HAST reliability data for AO4609 and AO4609L comes from the AOS generic package qualification data.

#### IV. Reliability Evaluation

**FIT rate (per billion): 64**

**MTTF = 1784 years**

500 hrs of HTGB, 150 deg C accelerated stress testing is equivalent to 15 years of lifetime at 55 deg C operating conditions (by applying the Arrhenius equation with an activation energy of 0.7eV and 60% of upper confidence level on the failure rate calculation). AOS reliability group also routinely monitors the product reliability up to 1000 hr at and performs the necessary failure analysis on the units failed for reliability test(s).

The presentation of FIT rate for the individual product reliability is restricted by the actual burn-in sample size of the selected product (AO4609). Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

$$\text{Failure Rate} = \text{Chi}^2 \times 10^9 / [2 (N) (H) (Af)] = 1.83 \times 10^9 / [2 (2 \times 164) (168) (258)] = 64$$

$$\text{MTTF} = 10^9 / \text{FIT} = 1.56 \times 10^7 \text{ hrs} = 1784 \text{ years}$$

**Chi<sup>2</sup>** = Chi Squared Distribution, determined by the number of failures and confidence interval

**N** = Total Number of units from HTRB and HTGB tests

**H** = Duration of HTRB/HTGB testing

**Af** = Acceleration Factor from Test to Use Conditions (Ea = 0.7eV and Tuse = 55°C)

$$\text{Acceleration Factor [Af]} = \text{Exp} [Ea / k ( 1/Tj u - 1/Tj s )]$$

**Acceleration Factor ratio list:**

	55 deg C	70 deg C	85 deg C	100 deg C	115 deg C	130 deg C	150 deg C
<b>Af</b>	<b>258</b>	<b>87</b>	<b>32</b>	<b>13</b>	<b>5.64</b>	<b>2.59</b>	<b>1</b>

**Tj s** = Stressed junction temperature in degree (Kelvin), K = C+273.16

**Tj u** = The use junction temperature in degree (Kelvin), K = C+273.16

**k** = Boltzmann's constant, 8.617164 X 10<sup>-5</sup>eV / K



## **V. Quality Assurance Information**

Acceptable Quality Level for outgoing inspection: **0.1%** for electrical and visual.

Guaranteed Outgoing Defect Rate: **< 25 ppm**

Quality Sample Plan: conform to **Mil-Std-105D**