ALPHA & OMEGA SEMICONDUCTOR

AOS Semiconductor
Product Reliability Report

AO4600/AO4600L, rev D

Plastic Encapsulated Device

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This AOS product reliability report summarizes the qualification result for AO4600. 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 AO4600 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 AO4600 uses advanced trench technology to provide excellent $R_{DS(ON)}$ and low gate charge. The complementary MOSFETs form a high-speed power inverter, suitable for a multitude of applications. Standard Product AO4600 is Pb-free (meets ROHS & Sony 259 specifications).

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}	±12	±12	V
Continuous Drain Current	T_A=25°C	I_D	6.9	-5	A
	T_A=70°C		5.8	-4.2	
Pulsed Drain Current		I_{DM}	40	-30	
Power Dissipation	T_A=25°C	P_D	2	2	W
	T_A=70°C		1.44	1.44	
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	t ≤ 10s	$R_{\theta JA}$	n-ch	48	62.5	°C/W
Maximum Junction-to-Ambient	Steady-State		n-ch	74	110	
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	n-ch	35	40	

II. Package Information:

	AO4600	AO4600L (Green Compound)
Process	Standard sub-micron low voltage N/P channel process	Standard sub-micron low voltage N/P channel process
Package Type	8 lead SOIC	8 lead SOIC
Lead Frame	Copper with Ag spot	Copper with Ag spot
Die Attach	Silver epoxy	Silver epoxy
Bond wire	2 mils Au wire	2 mils Au wire
Mold Material	Epoxy resin with silica filler	Epoxy resin with silica filler
Filler% (Spherical/Flake)	90/10	100/0
Flammability Rating	UL-94 V-0	UL-94 V-0
Backside Metallization	Ti / Ni / Ag	Ti / Ni / Ag
Moisture Level	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 AO4600 (Standard) & AO4600L (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: 83 lots** **Green: 29 lots**	**17380 pcs**	**0**
HTGB	**Temp = 150°C, Vgs=100% of Vgsmax**	**168 / 500 hrs 1000 hrs**	**6 lots** **(Note A*)**	**492 pcs** **77+5 pcs / lot**	**0**
HTRB	**Temp = 150°C, Vds=80% of Vdsmax**	**168 / 500 hrs 1000 hrs**	**6 lots** **(Note A*)**	**492 pcs** **77+5 pcs / lot**	**0**
HAST	**130 +/- 2°C, 85%RH, 33.3 psi, Vgs = 80% of Vgs max**	**100 hrs**	**Standard: 81 lots** **Green: 16 lots** **(Note B**)**	**5335 pcs** **50+5 pcs / lot**	**0**
Pressure Pot	**121°C, 29.7psi, RH=100%**	**96 hrs**	**Standard: 83 lots** **Green: 20 lots** **(Note B**)**	**5665 pcs** **50+5 pcs / lot**	**0**
Temperature Cycle	**-65°C to 150°C, air to air,**	**250 / 500 cycles**	**Standard: 87 lots** **Green: 29 lots** **(Note B**)**	**6380 pcs** **50+5 pcs / lot**	**0**
High Temperature Storage	**Temp = 150°C**	**500/1000hrs**	**Standard: 24 lots** **Green: 0 lot** **(Note B**)**	**1968 pcs** **77+5 pcs / lot**	**0**

III. Result of Reliability Stress for AO4600 (Standard) & AO4600L (Green)
Continues

DPA	**Internal Vision** **Cross-section** **X-ray**	**NA**	**5** **5** **5**	**5** **5** **5**	**0**
CSAM		**NA**	**5**	**5**	**0**
Bond Integrity	**Room Temp** **150°C bake** **150°C bake**	**0hr** **250hr** **500hr**	**40** **40** **40**	**40 wires** **40 wires** **40 wires**	**0**
Solderability	**245°C**	**5 sec**	**15**	**15 leads**	**0**

Note A: The HTGB and HTRB reliability data presents total of available AO4600 and AO4600L burn-in data up to the published date.
Note B: The pressure pot, temperature cycle, HAST and HTS reliability data for AO4600 and AO4600L comes from the AOS generic package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 9.9
MTTF = 11530 years

In general,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 (AO4600). Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

Failure Rate = $Chi^2 \times 10^9$ **/ [**2 (N) (H) (Af)**]**
= 1.83×10^9 / 2**[**(4×164) (168) (258) + (164) (500) (258) + (164) (1000) (258)**]**
= 9.9
MTTF = 10^9 / FIT = 1.01×10^8hrs = 11530years

Chi² = 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)
Acceleration Factor [Af**]** = **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
Af	**258**	**87**	**32**	**13**	**5.64**	**2.59**	**1**

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, 8.617164×10^{-5}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**