ALPHA & OMEGA SEMICONDUCTOR

AOS Semiconductor Product Reliability Report

AO4407 / AO4407L, rev D

Plastic Encapsulated Device

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Dec 27, 2005

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This AOS product reliability report summarizes the qualification result for AO4407. 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 AO4407 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 AO4407 uses advanced trench technology to provide excellent $R_{DS(ON)}$, and ultra-low low gate charge with a 25V gate rating. This device is suitable for use as a load switch or in PWM applications. Standard Product AO4407 is Pb-free (meets ROHS & Sony 259 specifications). AO4407L is a Green Product ordering option. AO4407 and AO4407L are electrically identical.

Absolute Maximum Ratings T_A=25°C unless otherwise noted				
Parameter		**Symbol**	**Maximum**	**Units**
Drain-Source Voltage		V_{DS}	-30	V
Gate-Source Voltage		V_{GS}	±25	V
Continuous Drain Current	T_A=25°C	I_D	-12	A
	T_A=70°C		-10	
Pulsed Drain Current		I_{DM}	-60	
Power Dissipation	T_A=25°C	P_D	3	W
	T_A=70°C		2.1	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	°C

Thermal Characteristics					
Parameter		**Symbol**	**Typ**	**Max**	**Units**
Maximum Junction-to-Ambient	T ≤ 10s	$R_{\theta JA}$	28	40	°C/W
Maximum Junction-to-Ambient	Steady-State		54	75	°C/W
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	21	30	°C/W

II. Die / Package Information:

	AO4407	AO4407L (Green Compound)
Process	Standard sub-micron low voltage P channel process	Standard sub-micron low voltage P channel process
Package Type	8 leads SOIC	8 leads SOIC
Lead Frame	Ag with Solder Plate	Ag with Solder Plate
Die Attach	Silver-filled Epoxy	Silver-filled 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 AO4407 (Standard) & AO4407L (Green)

Test Item	Test Condition	Time Point	Lot Attribution	Total Sample size	Number of Failures
Solder Reflow Precondition	**Standard: 1hrPCT+3 cycle reflow@260°c Green: 168hr 85°c /85%RH +3 cycle reflow@260°c**	**0hr**	**Standard: 6 lots Green: 16 lots**	**3300 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: 6 lots Green: 13 lots (Note B**)**	**1045 pcs 50+5 pcs / lot**	**0**
Pressure Pot	**121°c, 15+/-1 PSIG, RH=100%**	**96 hrs**	**Standard: 5 lots Green: 16 lots (Note B**)**	**1155 pcs 50+5 pcs / lot**	**0**
Temperature Cycle	**-65°c to 150°c, air to air, 0.5hr per cycle**	**250 / 500 cycles**	**Standard: 5 lots Green: 15 lots (Note B**)**	**1100 pcs 50+5 pcs / lot**	**0**

III. Result of Reliability Stress for AO4407 (Standard) & AO4407L (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	**230°c**	**5 sec**	**15**	**15 leads**	**0**
Die Shear	**150°c**	**0hr**	**10**	**10**	**0**

Note A: The HTGB and HTRB reliability data presents total of available AO4407 and AO4407L burn-in data up to the published date.
Note B: The pressure pot, temperature cycle and HAST reliability data for AO4407 and AO4407L comes from the AOS generic package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 7

MTTF =16307 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 (AO3401). 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 (3×164) (168) (258) + 2 (164) (500)(258) + 2 (2×164) (1000) (258)**]**
= 7
MTTF = 10^9 / FIT = 1.42×10^8hrs =16307 years

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 X 10^{-5}e V / 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**