ALPHA & OMEGA SEMICONDUCTOR

AOS Semiconductor Product Reliability Report

AO4409 / AO4409L, rev B

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

495 Mercury Drive
Sunnyvale, CA 94085
U.S.

Tel: (408) 830-9742 **www.aosmd.com**

Nov 24, 2004

ALPHA & OMEGA SEMICONDUCTOR

This AOS product reliability report summarizes the qualification result for AO4409. 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 AO4409 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.

Table of Contents:

I. Product Description
II. Package and Die information
III. Environmental Stress Test Summary and Result
IV. Reliability Evaluation
V. Quality Assurance Information

I. Product Description:

AO4409 / AO4409L, a p channel MOSFET, is mostly used as a bi-directional load switch for battery protection. The device stays in the ON-state during battery charging & discharging most of the time. It is in OFF state only under over-charge / over-discharge conditions. The device transition slowly between on and off states. AO4409 uses advance sub-micron technology on wafer manufacturing.

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}	±20	V
Continuous Drain Current [A]	T_A=25°C	I_D	-15	A
	T_A=70°C		-12.8	
Pulsed Drain Current [B]		I_{DM}	-80	
Power Dissipation [A]	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	$R_{\theta JA}$	26	40	°C/W
Maximum Junction-to-Ambient	Steady-State		50	75	°C/W
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	14	24	°C/W

ALPHA & OMEGA SEMICONDUCTOR

II. Die / Package Information:

	AO4409	AO4409L (Green Compound)
Process	Standard sub-micron low voltage P channel process	Standard sub-micron low voltage P channel process
Package Type	8 lead SO	8 lead SO
Lead Frame	Copper with Solder Plate	Copper with Solder Plate
Die Attach	Silver-filled Epoxy	Silver-filled Epoxy
Bondwire	2 mils Au wire	2 mils Au wire
Mold Material	Epoxy resin with silica filler	Epoxy resin with silica filler
Filler % (Spherical/Flake)	50/50	100/0
Flammability Rating	UL-94 V-0	UL-94 V-0
Backside Metallization	Ti / N / Ag	Ti / N / 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 AO4409 (Standard) & AO4409L (Green)

Test Item	Test Condition	Time Point	Lot Attribution	Total Sample size	Number of Failures
HTGB	Temp = 150 C, Vgs=100% of Vgsmax	168 / 500 hrs 1000 hrs	AO4409: 4 lots **AO4409L: 1 lot** (note A*)	410 pcs 77+5 pcs / lot	0
HTRB	Temp = 150 C, Vds=80% of Vdsmax	168 / 500 hrs 1000 hrs	AO4409: 4 lots **AO4409L: 1 lot** (note A*)	410 pcs 77+5 pcs / lot	0
HAST	130 +/- 2 C, 85%, 33.3 psi, Vgs = 80% of Vgs max	100 hrs	Standard compound: 3 lots **Green compound: 7 lots (note B**)**	550 pcs (10 lots) 50+5 pcs / lot	0
Pressure Pot	121 C, 15+/-1 PSIG, RH=100%	96 hrs	Standard compound: 3 lots **Green compound: 8 lots ** (note B**)**	605 pcs (11 lots) 50+5 pcs / lot	0
Temperature Cycle	-65 to 150 deg C, air to air, 0.5hr per cycle	250 / 500 cycles	Standard compound: 3 lots **Green compound: 6 lots ** (note B**)**	495 pcs (9 lots) 50+5 pcs / lot	0
ESD Rating	Human Body Mode MIL-STD 883D Method 3025.7	3500V	10 pcs each from AO4409 and AO4409L	20 pcs	0

III. Result of Reliability Stress for AO4405 (Standard) & AO4405L (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 AO4409 and AO4409L burn-in data up to the published date.
Note B: The pressure pot, temperature cycle and HAST reliability data for **AO4409L** comes from the AOS generic green compound package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 8.64.

MTBF=13212 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 (AO4409). 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 (820) (500) (258.24) **]** = 8.64

MTBF = 10^9 / FIT = 1.16×10^8hrs = 13212years

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 = 55C)

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 = Boltznan's constant, 8.617164 X 10 E^{-5}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**