



# **AOS Semiconductor Product Reliability Report**

**AO4413/AO4413L, rev D**

**Plastic Encapsulated Device**

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This AOS product reliability report summarizes the qualification result for AO4413. 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 AO4413 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 AO4413 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. AO4413L (Green Product) is offered in a lead-free package. AO4413 is Pb-free (meets ROHS & Sony 259 specifications).

Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted			
Parameter	Symbol	Maximum	Units
Drain-Source Voltage	$V_{DS}$	-30	V
Gate-Source Voltage	$V_{GS}$	$\pm 25$	V
Continuous Drain Current	$T_A=25^\circ\text{C}$	-15	A
	$T_A=70^\circ\text{C}$	-12.8	
Pulsed Drain Current	$I_{DM}$	-80	
Power Dissipation	$T_A=25^\circ\text{C}$	3	W
	$T_A=70^\circ\text{C}$	2.1	
Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to 150	$^\circ\text{C}$

Thermal Characteristics					
Parameter		Symbol	Typ	Max	Units
Maximum Junction-to-Ambient	$T \leq 10\text{s}$	$R_{\theta JA}$	26	40	$^\circ\text{C/W}$
Maximum Junction-to-Ambient	Steady-State		50	75	$^\circ\text{C/W}$
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	14	24	$^\circ\text{C/W}$

## II. Die / Package Information:

	<b>AO4413</b>	<b>AO4413L (Green Compound)</b>
<b>Process</b>	Standard sub-micron Low voltage P channel process	Standard sub-micron Low voltage P channel process
<b>Package Type</b>	8 leads SOIC	8 leads SOIC
<b>Lead Frame</b>	Cu, S/PAD, Ag spot	Cu, S/PAD, Ag spot
<b>Die Attach</b>	Ag epoxy	Ag epoxy
<b>Bond wire</b>	Au 2mils	Au 2 mils
<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 AO4413 (Standard) & AO4413L (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 /85RH +3 cycle reflow@260°C	0hr	Standard: 3 lots Green: 3 lots	935 pcs	0
HTGB	Temp = 150°C , Vgs=100% of Vgsmax	168 / 500 hrs 1000 hrs	9 lots  (Note A*)	738 pcs  77+5 pcs / lot	0
HTRB	Temp = 150°C , Vds=80% of Vdsmax	168 / 500 hrs 1000 hrs	9 lots  (Note A*)	738 pcs  77+5 pcs / lot	0
HAST	130 +/- 2°C , 85%RH, 33.3 psi, Vgs = 80% of Vgs max	100 hrs	Standard: 11 lots Green: 3 lots  (Note B*)	770 pcs  50+5 pcs / lot	0
Pressure Pot	121°C , 29.7psi, RH=100%	96 hrs	Standard: 11 lots Green: 3 lots  (Note B*)	770 pcs  50+5 pcs / lot	0
Temperature Cycle	-65 to 150°C , air to air,	250 / 500 cycles	Standard: 17 lots Green: 3 lots  (Note B*)	1100 pcs  50+5 pcs / lot	0
High Temperature Storage	Temp = 150°C	500/1000hrs	Standard: 24 lots   (Note B**)	1968 pcs  77+5 pcs / lot	0

### III. Result of Reliability Stress for AO4413 (Standard) & AO4413L (Green) Continues

<b>DPA</b>	Internal Vision Cross-section X-ray	NA	5 5 5	5 5 5	0
<b>CSAM</b>		NA	5	5	0
<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>	245°C	5 sec	15	15 leads	0
<b>Die shear</b>	150°C	0hr	10	10	0

**Note A:** The HTGB and HTRB reliability data presents total of available AO4413 and AO4413L burn-in data up to the published date.

**Note B:** The pressure pot, temperature cycle and HAST reliability data for AO4435 and AO4435L comes from the AOS generic package qualification data.

### IV. Reliability Evaluation

**FIT rate (per billion): 3.6**

**MTTF = 31709 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 (AO4413). Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

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

$$= 1.83 \times 10^9 / [2 (3 \times 164) (1000) (258) + 2 (6 \times 164) (500) (258)] = 3.6$$

$$\text{MTTF} = 10^9 / \text{FIT} = 2.77 \times 10^8 \text{hrs} = 31709 \text{years}$$

**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)

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

**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**