

AOS Semiconductor

Product Reliability Report

AO3411/AO3411L, rev A

Plastic Encapsulated Device

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This AOS product reliability report summarizes the qualification result for AO3411. 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 AO3411 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 AO3411 uses advanced trench technology to provide excellent $R_{DS(ON)}$, low gate charge and operation with gate voltages as low as 1.8V. This device is suitable for use as a load switch or in PWM applications. AO3411L (Green Product) is offered in a lead-free package.

| Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted | | | | |
|--|------------------------|----------------|------------|------------------|
| Parameter | | Symbol | Maximum | Units |
| Drain-Source Voltage | | V_{DS} | -20 | V |
| Gate-Source Voltage | | V_{GS} | ± 8 | V |
| Continuous Drain Current ^A | $T_A=25^\circ\text{C}$ | I_D | -4.4 | A |
| | $T_A=70^\circ\text{C}$ | | -3.5 | |
| Pulsed Drain Current ^B | | I_{DM} | -30 | |
| Power Dissipation ^A | $T_A=25^\circ\text{C}$ | P_D | 1.4 | W |
| | $T_A=70^\circ\text{C}$ | | 0.9 | |
| 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 = 10s | $R_{\theta JA}$ | 65 | 90 | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient | Steady-State | | 85 | 125 | $^\circ\text{C/W}$ |
| Maximum Junction-to-Lead | Steady-State | $R_{\theta JL}$ | 43 | 60 | $^\circ\text{C/W}$ |

II. Die / Package Information:

| | AO3411 | AO3411L (Green Compound) |
|-----------------------------------|--|--|
| Process | Standard sub-micron low voltage P channel process | Standard sub-micron low voltage P channel process |
| Package Type | 3 leads SOT | 3 leads SOT |
| Lead Frame | Copper with Solder Plate | Copper with Solder Plate |
| Die Attach | Ag epoxy | Ag epoxy |
| Bond wire | Au 2mils | Au 2mils |
| 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 / 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 AO3411 (Standard) & AO3411L (Green)

| Test Item | Test Condition | Time Point | Lot Attribution | Total Sample size | Number of Failures |
|----------------------------|---|-------------------------------|--|--------------------------------|--------------------|
| Solder Reflow Precondition | Normal: 1hr PCT+3 cycle IR reflow @240 °c (260° c for Green) | 0hr | Normal: 19 lots Green: 5 lots | 3795 pcs | 0 |
| HTGB | Temp = 150 C, Vgs=100% of Vgsmax | 168 / 500 hrs 1000 hrs | Normal: 1 lot (Note A*) | 82 pcs 77+5 pcs / lot | 0 |
| HTRB | Temp = 150 C, Vds=80% of Vdsmax | 168 / 500 hrs 1000 hrs | Normal: 1 lot (Note A*) | 82 pcs 77+5 pcs / lot | 0 |
| HAST | 130 +/- 2 C, 85%, 33.3 psi, Vgs = 80% of Vgs max | 100 hrs | Normal: 19 lots Green: 4 lots (Note B**) | 1265 pcs 50+5 pcs / lot | 0 |
| Pressure Pot | 121 C, 15+/-1 PSIG, RH=100% | 96 hrs | Normal: 18 lots Green: 5 lots (Note B**) | 1265 pcs 50+5 pcs / lot | 0 |
| Temperature Cycle | -65 to 150 deg C, air to air, 0.5hr per cycle | 250 / 500 cycles | Normal: 19 lots Green: 4 lots (Note B**) | 1265 pcs 50+5 pcs / lot | 0 |

III. Result of Reliability Stress for AO3411 (Standard) & AO3411L (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 AO3411 and **AO3411L** burn-in data up to the published date.

Note B: The pressure pot, temperature cycle and HAST reliability data for **AO3411L** comes from the AOS generic green compound package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 43

MTBF = 2654 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 (AO3411). Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

$$\text{Failure Rate} = \text{Chi}^2 \times 10^9 / [2 (N) (H) (Af)] = 1.83 \times 10^9 / [2 (164) (500) (258)] = 43$$

$$\text{MTBF} = 10^9 / \text{FIT} = 2.32 \times 10^7 \text{ hrs} = 2654 \text{ years}$$

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 = 55C)

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

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 |
|-----------|------------|-----------|-----------|-----------|-------------|-------------|-----------|
| 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 = Boltzman's constant, 8.617164 X 10 E⁻⁵V / 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**

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