



ALPHA & OMEGA
SEMICONDUCTOR

AOS Semiconductor Product Reliability Report

AOD454/AOD454L, rev C

Plastic Encapsulated Device

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This AOS product reliability report summarizes the qualification result for AOD454. 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 AOD454 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 AOD454 uses advanced trench technology and design to provide excellent $R_{DS(ON)}$ with low gate charge. This device is suitable for use in PWM, load switching and general purpose applications. Standard product AOD454 is Pb-free (meet ROHS & Sony 259 specifications). AOD454L is a Green Product ordering option. AOD454 and AOD454L are electrically identical.

| Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted | | | | |
|--|-------------------------|------------|------------------|--|
| Parameter | Symbol | Maximum | Units | |
| Drain-Source Voltage | V_{DS} | 40 | V | |
| Gate-Source Voltage | V_{GS} | ± 20 | V | |
| Continuous Drain Current ^G | $T_A=25^\circ\text{C}$ | 12 | A | |
| | $T_A=100^\circ\text{C}$ | 12 | | |
| Pulsed Drain Current ^C | I_{DM} | 30 | | |
| Avalanche Current ^C | I_{AR} | 12 | A | |
| Power Dissipation ^B | $T_A=25^\circ\text{C}$ | 20 | W | |
| | $T_A=100^\circ\text{C}$ | 10 | | |
| Power Dissipation ^A | $T_A=25^\circ\text{C}$ | 2 | W | |
| | $T_A=100^\circ\text{C}$ | 1.3 | | |
| Junction and Storage Temperature Range | T_J, T_{STG} | -55 to 175 | $^\circ\text{C}$ | |

| Thermal Characteristics | | | | | |
|-----------------------------|-----------------|------|-----|---------------------|--------------------|
| Parameter | Symbol | Typ | Max | Units | |
| Maximum Junction-to-Ambient | $R_{\theta JA}$ | 17.4 | 30 | $T \leq 10\text{s}$ | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient | | | | Steady-State | |
| Maximum Junction-to-Lead | $R_{\theta JL}$ | 4 | 7.5 | Steady-State | $^\circ\text{C/W}$ |

II. Die / Package Information:

| | AOD454 | AOD454L (Green Compound) |
|-----------------------------------|--|--|
| Process | Standard sub-micron low voltage N channel process | Standard sub-micron low voltage N channel process |
| Package Type | 3 leads TO252 | 3 leads TO252 |
| Lead Frame | Copper with Ag pad | Copper with Ag pad |
| Die Attach | Soft solder | Soft solder |
| 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 AOD454 (Standard) & AOD454L (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@260 °c (168hrs 85°C /85%RH +Reflow@260°C for Green) | 0hr | Normal: 20 lots Green: 2 lots | 3190pcs | 0 |
| HTGB | Temp = 150° C, Vgs=100% of Vgsmax | 168 / 500 hrs 1000 hrs | Normal: 1 lot (Note A*) | 82pcs 77+5 pcs / lot | 0 |
| HTRB | Temp = 150° C, Vds=80% of Vdsmax | 168 / 500 hrs 1000 hrs | Normal: 1 lot (Note A*) | 82pcs 77+5 pcs / lot | 0 |
| HAST | 130 +/- 2° C, 85%RH, 33.3 psi, Vgs = 80% of Vgs max | 100 hrs | Normal: 16 lots Green: 1 lots (Note B**) | 935pcs 50+5 pcs / lot | 0 |
| Pressure Pot | 121° C, 15+/-1 PSIG, RH=100% | 96 hrs | Normal: 20 lots Green: 1 lots (Note B**) | 1155pcs 50+5 pcs / lot | 0 |
| Temperature Cycle | -65 to 150 ° C, air to air, 0.5hr per cycle | 250 / 500 cycles | Normal: 18 lots Green: 2 lots (Note B**) | 1100pcs 50+5 pcs / lot | 0 |

III. Result of Reliability Stress for AOD454 (Standard) & AOD454L (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 AOD454 and AOD454L burn-in data up to the published date.

Note B: The pressure pot, temperature cycle and HAST reliability data for AOD454L comes from the AOS generic green compound package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 128

MTTF = 891years

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 (AOD454). Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

$$\text{Failure Rate} = \text{Chi}^2 \times 10^9 / [2 (N) (H) (Af)] = 1.83 \times 10^9 / [2 (164) (168) (258)] = 128$$

$$\text{MTTF} = 10^9 / \text{FIT} = 7.8 \times 10^6 \text{hrs} = 891 \text{ years}$$

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)

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 |
|-----------|-----------------|-----------------|-----------------|------------------|------------------|------------------|------------------|
| 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 10⁻⁵V / 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**