ALPHA & OMEGA SEMICONDUCTOR

AOS Semiconductor Product Reliability Report

AOD444/AOD444L, rev B

Plastic Encapsulated Device

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This AOS product reliability report summarizes the qualification result for AOD444. 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 AOD444 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 AOD444 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 AOD444 is Pb-free (meets ROHS & Sony 259 specifications).

Absolute Maximum Ratings T_A=25°C unless otherwise noted				
Parameter		**Symbol**	**Maximum**	**Units**
Drain-Source Voltage		V_{DS}	60	V
Gate-Source Voltage		V_{GS}	±20	V
Continuous Drain Current	T_A=25°C	I_D	12	A
	T_A=100°C		12	
Pulsed Drain Current		I_{DM}	30	
Power Dissipation	T_A=25°C	P_D	20	W
	T_A=100°C		10	
Power Dissipation	T_A=25°C	P_{DSM}	2	W
	T_A=70°C		1.3	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 175	°C

Thermal Characteristics					
Parameter		**Symbol**	**Typ**	**Max**	**Units**
Maximum Junction-to-Ambient	T ≤ 10s	$R_{\theta JA}$	17.4	30	°C/W
Maximum Junction-to-Ambient	Steady-State		50	60	°C/W
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	4	7.5	°C/W

II. Die / Package Information:

	AOD444	AOD444L (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	Bare Cu	Bare Cu
Die Attach	Soft solder	Soft solder
Bond wire	S: Al, 12mils; G: Au, 1.3mils	S: Al, 12mils; G: Au, 1.3mils
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 AOD444 (Standard) & AOD444L (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 /85%RH +3 cycle reflow@260°c**	**0hr**	**Standard: 26 lots** **Green: 3 lots**	**4675pcs**	**0**
HTGB	**Temp = 150°c , Vgs=100% of Vgsmax**	**168 / 500 hrs** **1000 hrs**	**4 lots** **(Note A*)**	**328pcs** **77+5 pcs / lot**	**0**
HTRB	**Temp = 150°c , Vds=80% of Vdsmax**	**168 / 500 hrs** **1000 hrs**	**4 lots** **(Note A*)**	**328pcs** **77+5 pcs / lot**	**0**
HAST	**130 +/- 2°c , 85%RH, 33.3 psi, Vgs = 80% of Vgs max**	**100 hrs**	**Standard : 26 lots** **Green: 3 lots** **(Note B**)**	**1595pcs** **50+5 pcs / lot**	**0**
Pressure Pot	**121°c , 29.7psi, 100%RH**	**96 hrs**	**Standard : 25 lots** **Green: 3 lots** **(Note B**)**	**1540pcs** **50+5 pcs / lot**	**0**
Temperature Cycle	**-65°c to 150°c , air to air,**	**250 / 500 cycles**	**Standard : 25 lots** **Green: 3 lots** **(Note B**)**	**1540pcs** **50+5 pcs / lot**	**0**

III. Result of Reliability Stress for AOD444 (Standard) & AOD444L (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	**245°c**	**5 sec**	**15**	**15 leads**	**0**

Note A: The HTGB and HTRB reliability data presents total of available AOD444 and AOD444L burn-in data up to the published date.
Note B: The pressure pot, temperature cycle, HAST and HTS reliability data for AOD444 and AOD444L comes from the AOS generic package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 10
MTTF = 11415 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 (AOD444). 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 (164) (168) (258) + 2 (2x164) (500) (258) + 2 (164) (1000) (258)**]**
= 10
MTTF = 10^9 / FIT = 1.0×10^8hrs = 11415years

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}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**