ALPHA & OMEGA SEMICONDUCTOR

Alpha & Omega Semiconductor Product Reliability Report

AO4478/AO4478L, rev A

Plastic Encapsulated Device

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This AOS product reliability report summarizes the qualification result for AO4478. 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 AO4478 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 AO4478/L uses advanced trench technology to provide excellent $R_{DS(ON)}$ and low gate charge. This device is suitable for use as general purpose, PWM and a load switch appliations.

- RoHS compliant
- Halogen Free

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}	±25	V
Continuous Drain Current	T_A=25°C	I_D	9.0	A
	T_A=70°C		7.0	
Pulsed Drain Current [C]		I_{DM}	60	
Avalanche Current [C]		Iar	17	
Repetitive avalanche energy L=0.1mH [C]		Ear	14	mJ
Power Dissipation [B]	T_A=25°C	P_D	3.1	W
	T_A=70°C		2.0	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	°C

Thermal Characteristics					
Parameter		**Symbol**	**Typ**	**Max**	**Units**
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	31	40	°C/W
Maximum Junction-to-Ambient [AD]	Steady-State		59	75	°C/W
Maximum Junction-to-Lead [C]	Steady-State	$R_{\theta JL}$	16	24	°C/W

II. Die / Package Information:

	AO4478	AO4478L (Green Compound)
Process	Standard sub-micron low voltage N channel process	Standard sub-micron low voltage N channel process
Package Type	8 leads SOIC	8 leads SOIC
Lead Frame	Copper with Solder Plate	Copper with Solder Plate
Die Attach	Ag epoxy	Ag epoxy
Bond wire	Au 2 mils	Au 2 mils
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 AO4478 (Standard) & AO4478L (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: 49 lots** **Green: 16 lots**	**9625 pcs**	**0**
HTGB	**Temp = 150°c , Vgs=100% of Vgsmax**	**168 / 500 hrs** **1000 hrs**	**1lots** **(note A*)**	**82 pcs** **77+5 pcs / lot**	**0**
HTRB	**Temp = 150°c , Vds=80% of Vdsmax**	**168 / 500 hrs** **1000 hrs**	**1lots** **(note A*)**	**82 pcs** **77+5 pcs / lot**	**0**
HAST	**130 +/- 2°c , 85%RH, 33.3 psi, Vgs = 80% of Vgs max**	**100 hrs**	**Standard: 33 lots** **Green: 13 lots** **(note B**)**	**2530 pcs** **50+5 pcs / lot**	**0**
Pressure Pot	**121°c , 29.7 psi, RH=100%**	**96 hrs**	**Standard: 49 lots** **Green: 16 lots** **(note B**)**	**3575 pcs** **50+5 pcs / lot**	**0**
Temperature Cycle	**-65°c to 150°c , air to air, 0.5hr per cycle**	**250 / 500 cycles**	**Standard: 49 lots** **Green: 15 lots** **(note B**)**	**3520 pcs** **50+5 pcs / lot**	**0**

III. Result of Reliability Stress for AO4478 (Standard) & AO4478L (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 AO4478 and AO4478L burn-in data up to the published date.
Note B: The pressure pot, temperature cycle and HAST reliability data for AO4478 and AO4478L comes from the AOS generic package qualification data.

IV. Reliability Evaluation

FIT rate (per billion):10.81
MTTF =10558years

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 QRA 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 (AO4478). 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 (2×164) (1000) (258) =10.81
MTTF = 10^9 / FIT = 9.25×10^7hrs = 10558 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 = 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, 8.617164×10^{-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**