Alpha & Omega Semiconductor

Reliability Annual Report_*2014*

ALPHA & OMEGA Semiconductor, Inc

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Commitment to Excellence at Quality & Reliability

To achieve this vision, AOS continuously strive for the excellence in design, manufacturing, reliability and proactively response to the customer's feedback.

AOS ensures that all the product quality and reliability exceed the customer's expectation by constantly assessing any potential risk, identifying cause of the suspected failures, driving corrective actions and developing prevention plan within the committed time through the continuously improvement.

This AOS product reliability report summarizes AOS Product Reliability result. The published product reliability data combines the results from new product Qualification Test Plan and routine Reliability Monitor Program activities. Accelerated environmental tests are performed on a specific sample size, and then followed by electrical test at end point. The released product will be categorized by the process family and be monitored on a monthly for short term program and quarterly basis for long term program. Table 1 lists the generic reliability qualification requirements and conditions for process / product in plastic package:

Table 1: AOS Generic Reliability Qualification Requirements

Test Item	Test Condition	Time Point	Sample Size	Acc/Reject & LTPD
HTGB	Temp = Tj, Vgs=100% of Vgsmax	168 / 500 / 1000 hours	77 pcs / lot	0/1 <3%
HTRB	Temp = Tj, Vds=80% of Vdsmax	168 / 500 / 1000 hours	77 pcs / lot	0/1 <3%
Solder reflow precondition	168hrs 85°C/85%RH + 3 cycles reflow@260°C (MSL 1)	-	The sum of PCT ,TC, HAST and H3TRB	0/1 <3%
HAST	130°C, 85%RH, 33.3 psia, Vds = 80% of Vdsmax up to 42V	96 hours	77 pcs / lot	0/1, <3%
H3TRB	85°C, 85%RH, Vds = 80% of Vdsmax up to 100V	1000 hours	77 pcs / lot	0/1, <3%
Autoclave	121°C, 29.7 psia, RH=100%	96 hours	77 pcs / lot	0/1, <3%
Temperature Cycle	-65 to 150°C, air to air	500 cycles	77 pcs / lot	0/1, <3%

High Temperature Gate Bias & High Temperature Reverse Bias (HTGB&HTRB)

HTGB burn-in stress is used to stress gate oxide at the elevated temperature environment hence any of the gate oxide integrity issue can be identified.
HTRB burn-in stress is used to verify junction degradation under the maximum operation temperature.

Through HTGB & HTRB B/I stress test, the device lifetime in field operation & long term device level reliability can be determined. FIT rate is calculated by applying the Arrhenius equation with the activation energy of 0.7eV and 60% of upper confidence level of "Chi-Square" (χ^2) distribution at 55 deg C operating conditions.

Solder reflow precondition (pre-con)

Solder reflow precondition is the test that simulates shipment and storage of package in uncontrollable environment. Precondition is the pre requirement for the mechanical related reliability tests, such as Temperature Cycle, Autoclave and Highly Accelerated Stress TEST (HAST). The routine of the test including parts are soaked in moisture in 85%RH, 85 deg C environment for 168 hrs. Then they will be run through a solder reflow oven 3 times to simulate the SMT stress condition.

Temperature Cycling (TC)

Temperature cycling test is to evaluate the mechanical integrity of the package and the interaction between the die and the package. This is an air to air test at temperature range from -65°C to 150°C and stress duration is from 250 cycles to 500 cycles, 2~3 cycles per hour.

Autoclave (AC)

Autoclave test is the test that measures the ability of the device withstand to moisture and contaminant environment. The test is done under enclosed chamber with the condition 121°C, 29.7 psia, 100%RH and stress duration is 96 hrs.

Highly Accelerated Stress Test (HAST)

Highly accelerated stress test is to stress the devices under high humidity, high pressure environment under DC bias condition. If ionic contamination involved, the corrosion from metal layer can be accelerated by the HAST stress condition.
(H3TRB is the alternative of HAST)

The following tables summarize the qualification results based on the device / process families and the package types, respectively.

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Summary of AOS Device / Process Qualification Monitor Results

To present the actual FIT rate from the different process and device technologies, AOS categorized the device / process family FIT rate by N channel and P channel.

Table 2 listed the summary of HTGB and HTRB results.

Table 2:

Process	Equivalent MTTF		Sample Size	# of failure	FIT
	In hours	In Years			
N channel	**3.73E+10**	**4255537**	**198352**	**0**	**0.06**
LV	1.18E+10	1347371	73150	0	0.08
MV	7.87E+09	897981	42812	0	0.13
HV	1.76E+10	2010185	82390	0	0.06
P channel	**3.61E+09**	**411691**	**23100**	**0**	**0.28**
LV	3.61E+09	411691	23100	0	0.28

Summary of AOS Package Qualification and Monitor Results

Package Name	Total stress hours or cycles*		
	AC	TC	HAST
CSP family	44352	231000	44352
DFN2x2 family	66528	346500	66528
DFN2x5	22176	115500	22176
DFN3x3 family	88704	462000	88704
DFN5x6 family	177408	924000	177408
DFN8x8	22176	115500	22176
SO8	66528	346500	66528
SOT23	88704	462000	88704
TO220	133056	693000	133056
TO220F	177408	924000	177408
TO247	177408	924000	177408
TO252(DPAK)	88704	462000	88704
TO263(D2PAK)	66528	346500	66528
TSOP6	22176	115500	22176

*Note: Total stress hours or cycles: sample size x stress time/cycle

The presentation of FIT rate for the individual product reliability is restricted by the actual burn-in sample size. Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

Failure Rate = Chi^2 x 10^9 **/ [**2 (N) (H) (Af)**]**
MTTF = 10^9 / FIT

Chi² = Chi Squared Distribution, determined by the number of failures and confidence interval
N = Total Number of units from burn-in tests
H = Duration of burn-in 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	**259**	**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