ALPHA & OMEGA SEMICONDUCTOR

AOS Semiconductor
Product Reliability Report

AOZ5116QI-03 rev A

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

475 Oakmead Parkway
Sunnyvale, CA 94085
United States

Tel: (408)830-9742
www.aosmd.com

ALPHA & OMEGA SEMICONDUCTOR

The AOS product reliability report summarizes the qualification results for AOZ5116QI-03 in QFN5x5-31L package. Accelerated environmental tests are performed on a specific sample size, samples are electrically tested before and after each stress time point. Review of final electrical test results confirm that AOZ5116QI-03 pass the AOS quality and reliability requirements. The released products will be categorized by its process family and routinely monitored for continuous improvement of product quality.

I. Reliability Stress Test Summary and Results

Test Item	Test Condition	Time Point	Sample Size / Lots	Number of Failures	Reference Standard
HTOL	T_J = 150°C, V_{IN} = 28V	168 / 500 / 1000 hours	231 pcs (3 lots)	0	JESD22-A108
Preconditioning (Note A)	T_A = 85°C, RH = 85% + 3 cycle reflow @ 260°C (MSL 1)	168hours	924 pcs (3 lots)	0	JESD22-A113
HAST	T_A = 130°C, RH = 85%, P = 33.3psia, V_{IN} = 28V	96 hours	231 pcs (3 lots)	0	JESD22-A110
Autoclave	T_A = 121°C, RH = 100%, P = 29.7psia	96 hours	231 pcs (3 lots)	0	JESD22-A102
Temperature Cycle	T_A = -65°C to 150°C, air to air	500 / 1000 cycles	231 pcs (3 lots)	0	JESD22-A104
HTSL	T_A = 150°C	1000 hours	231 pcs (3 lots)	0	JESD22-A103
Power Cycling	V_{IN} = 18V, V_{OUT} = 1.0V, F_{SW} = 600kHz, I_{OUT} = 22A, VCC cycled 0V-5V @ 1hz	24hrs, >86k cycles	10 pcs (3 lots)	0	AOS Standard
HTGB (MOSFET)	T_J = 150°C, V_{GS} = 12V	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A108
HTRB (MOSFET)	T_J = 150°C, V_{DS} = 30V / 20V	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A108
H3TRB (MOSFET)	T_A = 130°C, RH = 85%, P = 33.3psia, V_{DS} = 30V / 20V	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A101
Validation	3 cycle reflow @ 260°C + 250 cycles @ T_A = -65°C to 150°C	250 cycles	3000 (3 lots)	0	AOS Standard
Mechanical Shock	Condition B a = 1500g; t = 0.5ms	5 shocks / side	30 (3 lots)	0	JESD22-B110B

Note: The reliability data presents total of available generic data up to the published date.
Note A: MSL (Moisture Sensitivity Level) 1 based on J-STD-020

II. Reliability Evaluation

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

FIT rate (failures per billion device hours): 0.286
MTTF = 3,494.2 million hrs
Condition: V_o = 18V, T_o = 55°C, $V_{s(DriverIC)}$ = 28V, $V_{s(HS\ MOSFET)}$ = 30V, $V_{s(LS\ MOSFET)}$ = 20V and T_s = 150°C
Sample Size: MOSFET = 6,153, Driver IC = 8,669

The failure rate (λ) is calculated as follows:
$\lambda = \chi^2[CL,(2f+2)]\ /2 \times [1/(SS \times t \times AF)]$; [equation 1] where CL = % of confidence level
f = number of failure
SS = sample size
t = stress time

Looking up the χ^2 /2 table for zero failure (burn-in) with 60% confidence, the value of $\chi^2[CL,(2f+2)]$ /2 is 0.92.

The Acceleration Factor (AF) is calculated from the following formula (both temperature and voltage acceleration factors are used in the final acceleration factor calculation):
$AF = AF_T \times AF_V = \exp[(E_a/k) \times (1/T_0-1/T_s)] \times \exp[\beta\ (Vs-Vo)]$ where
E_a = activation energy
k = Boltzmann constant
T_o = operating T_J
T_s = stress T_J
V_s = stress voltage
V_o = operating voltage
β = voltage acceleration coefficient

Assuming typical operating environment, V_o = 25V, T_o = 55°C, E_a = 0.7eV, $V_{s(DriverIC)}$ = 28V, $V_{s(MOSFET)}$ = 30V, T_s = 150°C, β = 0.5 (silicon defect)

$$AF(DriverIC) = exp\left[\left(\frac{0.7}{8.617E-5}\right) \bullet \left(\frac{1}{273+55} - \frac{1}{273+150}\right)\right] \bullet exp[\,0.5 \bullet (28V - 18V)]$$

$$AF(HS\ MOSFET) = exp\left[\left(\frac{0.7}{8.617E-5}\right) \bullet \left(\frac{1}{273+55} - \frac{1}{273+150}\right)\right] \bullet exp[\,0.5 \bullet (30V - 18V)]$$

$$AF(LS\ MOSFET) = exp\left[\left(\frac{0.7}{8.617E-5}\right) \bullet \left(\frac{1}{273+55} - \frac{1}{273+150}\right)\right] \bullet exp[\,0.5 \bullet (20V - 18V)]$$

Substituting the values in equation 1, we have $\lambda = 2 \bullet \lambda(MOSFET) + \lambda(DriverIC) =$

$$0.92 \bullet \frac{2}{Sample\ Size \bullet Stress\ Duration \bullet AF(MOSFET)} + \frac{1}{sample\ Size \bullet Stress\ Duration \bullet AF(DriverIC)} hr^{-1}$$

$\lambda = 0.286\ 10^{-9}\ hr^{-1}$ or 0.286 FIT; MTTF = (1/ λ) = 3,494.2 million hrs = 398,877 years

The calculation shows failure rate is 0.286 FIT, MTTF is 3,494.2 million hours under typical operating conditions.

III. ESD and Latch Up Test Results

Test	Test Conditions	Total Sample Size	Number of Failures	Reference Standard
Electrostatic Discharge Human Body Model	**T_A = 25°C, +/-2kV**	**10**	**0**	**JESD-A114**
Electrostatic Discharge Charged Device Model	**T_A = 25°C, +/-1kV**	**10**	**0**	**JESD-C101**
Latch Up	**T_A = 25°C, +/-100mA, 1.5x OV**	**10**	**0**	**JESD78**
Latch Up	**T_A = 125°C, +/-100mA, 1.5x OV**	**10**	**0**	**JESD78**

Note: ATE results are used to determine PASS/FAIL. Parametric shift<10%.