

# ***AOS Semiconductor Product Reliability Report***

**AOZ5516QI-03** rev A

**Plastic Encapsulated Device**

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The AOS product reliability report summarizes the qualification results for AOZ5516QI-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 AOZ5516QI-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	$T_J = 150^{\circ}\text{C}$ , $V_{IN} = 28\text{V}$	168 / 500 / 1000 hours	231 pcs (3 lots)	0	JESD22-A108
Preconditioning (Note A)	$T_A = 85^{\circ}\text{C}$ , RH = 85% + 3 cycle reflow @ $260^{\circ}\text{C}$ (MSL 1)	168hours	924 pcs (3 lots)	0	JESD22-A113
HAST	$T_A = 130^{\circ}\text{C}$ , RH = 85%, P = 33.3psia, $V_{IN} = 28\text{V}$	96 hours	231 pcs (3 lots)	0	JESD22-A110
Autoclave	$T_A = 121^{\circ}\text{C}$ , RH = 100%, P = 29.7psia	96 hours	231 pcs (3 lots)	0	JESD22-A102
Temperature Cycle	$T_A = -65^{\circ}\text{C}$ to $150^{\circ}\text{C}$ , air to air	500 / 1000 cycles	231 pcs (3 lots)	0	JESD22-A104
HTSL	$T_A = 150^{\circ}\text{C}$	1000 hours	231 pcs (3 lots)	0	JESD22-A103
Power Cycling	$V_{IN} = 18\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $F_{SW}$ = 600kHz, $I_{OUT} = 22\text{A}$ , VCC cycled 0V-5V @ 1hz	24hrs, >86k cycles	10 pcs (3 lots)	0	AOS Standard
HTGB (MOSFET)	$T_J = 150^{\circ}\text{C}$ , $V_{GS} = 12\text{V}$	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A108
HTRB (MOSFET)	$T_J = 150^{\circ}\text{C}$ , $V_{DS} = 30\text{V} / 20\text{V}$	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A108
H3TRB (MOSFET)	$T_A = 130^{\circ}\text{C}$ , RH = 85%, P = 33.3psia, $V_{DS} = 30\text{V} / 20\text{V}$	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A101
Validation	3 cycle reflow @ $260^{\circ}\text{C}$ + 250 cycles @ $T_A = -65^{\circ}\text{C}$ to $150^{\circ}\text{C}$	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): 0.287**

**MTTF = 3,484.2 million hrs**

**Condition:**  $V_o = 18V$ ,  $T_o = 55^\circ C$ ,  $V_{s(DriverIC)} = 28V$ ,  $V_{s(HS MOSFET)} = 30V$ ,  $V_{s(LS MOSFET)} = 20V$  and  $T_s = 150^\circ C$

**Sample Size:** MOSFET = 6,153, Driver IC = 8,669

The failure rate ( $\lambda$ ) is calculated as follows:

$$\lambda = \chi^2[CL, (2f+2)] / 2 \times [1 / (SS \times t \times AF)]; \text{ [equation 1]} \quad \text{where} \quad \begin{array}{l} CL = \% \text{ of confidence level} \\ f = \text{number of failure} \\ SS = \text{sample size} \\ t = \text{stress time} \end{array}$$

Looking up the  $\chi^2/2$  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):

$$AF = AF_T \times AF_V = \exp[(E_a/k) \times (1/T_o - 1/T_s)] \times \exp[\beta (V_s - V_o)] \quad \text{where} \quad \begin{array}{l} E_a = \text{activation energy} \\ k = \text{Boltzmann constant} \\ T_o = \text{operating } T_J \\ T_s = \text{stress } T_J \\ V_s = \text{stress voltage} \\ V_o = \text{operating voltage} \\ \beta = \text{voltage acceleration coefficient} \end{array}$$

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

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

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

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

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

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

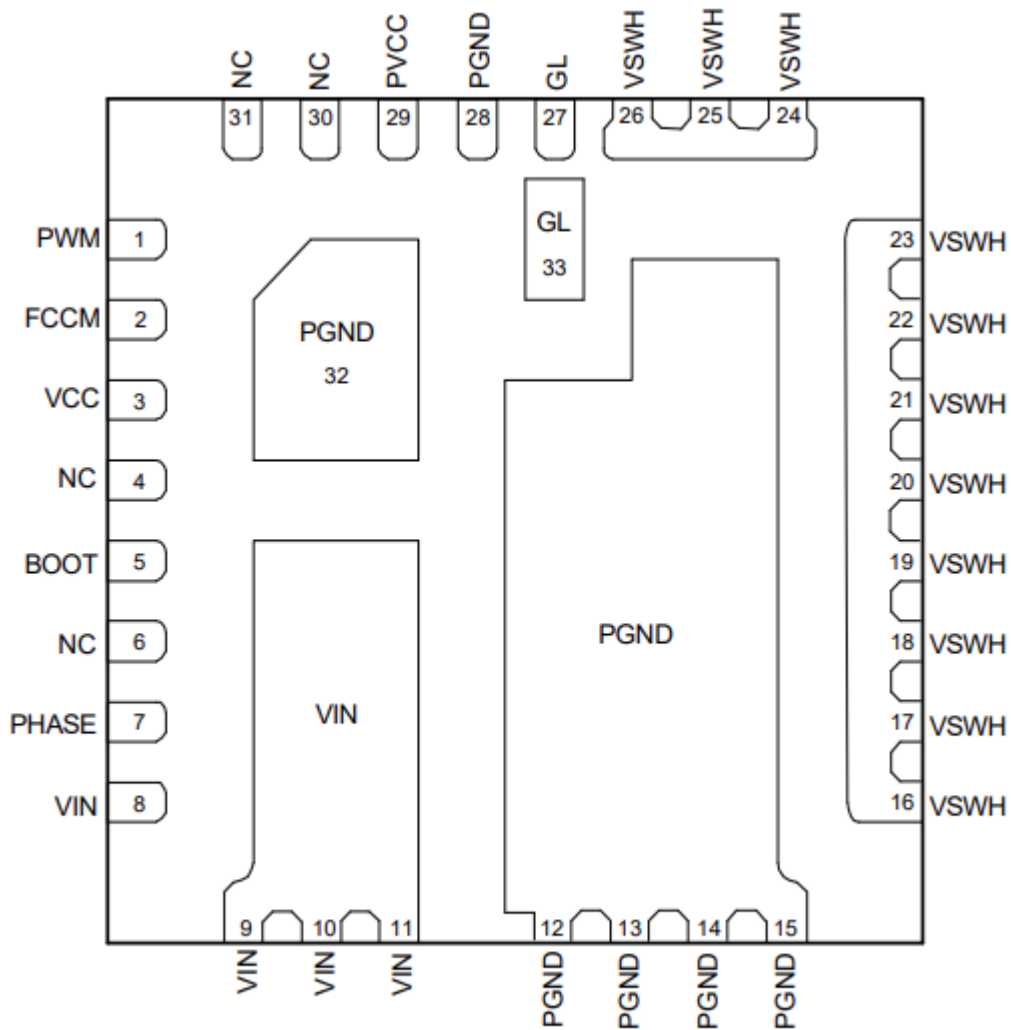
$\lambda = 0.287 \cdot 10^{-9} \text{ hr}^{-1}$  or 0.287 FIT; MTTF =  $(1/\lambda) = 3,484.2$  million hrs = 397,739 years

The calculation shows failure rate is 0.287 FIT, MTTF is 3,484.2 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 <sub>A</sub> = 25°C, +/-2kV	10	0	JESD-A114
Electrostatic Discharge Charged Device Model	T <sub>A</sub> = 25°C, +/-1kV	10	0	JESD-C101
Latch Up	T <sub>A</sub> = 25°C, +/-100mA, 1.5x OV	10	0	JESD78
Latch Up	T <sub>A</sub> = 125°C, +/-100mA, 1.5x OV	10	0	JESD78

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



**QFN5x5-31L  
(Top View)**