# *AOS Semiconductor*
# *Product Reliability Report*

## AOZ5317NQI-04 rev A

**Plastic Encapsulated Device**

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The AOS product reliability report summarizes the qualification results for AOZ5317NQI-04 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 AOZ5317NQI-04 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) | 168 hours | 924 pcs (3 lots) | 0 | JESD22-A113 |
| **HAST** | $T_A$ = 130°C, RH = 85%, P = 33.3psia, $V_{IN}$ = 30V | 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** | $V_{IN}$ = 24V, $V_{OUT}$ = 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 | 168 / 500 / 1000 hours | 231 (3 lots) | 0 | JESD22-A108 |
| **HT3RB (MOSFET)** | $T_A$ = 130°C, RH = 85%, P = 33.3psia, $V_{DS}$ = 30V | 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): 0.460**
**MTTF = 2,174.7 million hrs**
**Condition:** $V_o$ = 25V, $T_o$ = 55°C, $V_{s(DriverIC)}$ = 28V, $V_{s(MOSFET)}$ = 30V and $T_s$ = 150°C
**Sample Size:** MOSFET = 6,153, Driver IC = 3,874

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 $\chi^2$ /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) :
$AF = AF_T \times AF_V = \exp[(E_a/k) \times (1/T_0-1/T_s)] \times \exp[\beta (Vs-Vo)]$ 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)

$$AF(DriverIC) = \exp\left[\left(\frac{0.7}{8.617E-5}\right)\bullet\left(\frac{1}{273+55}-\frac{1}{273+150}\right)\right]\bullet\exp[0.5\bullet(28V-25V)]$$

$$AF(MOSFET) = \exp\left[\left(\frac{0.7}{8.617E-5}\right)\bullet\left(\frac{1}{273+55}-\frac{1}{273+150}\right)\right]\bullet\exp[0.5\bullet(30V-25V)]$$

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

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

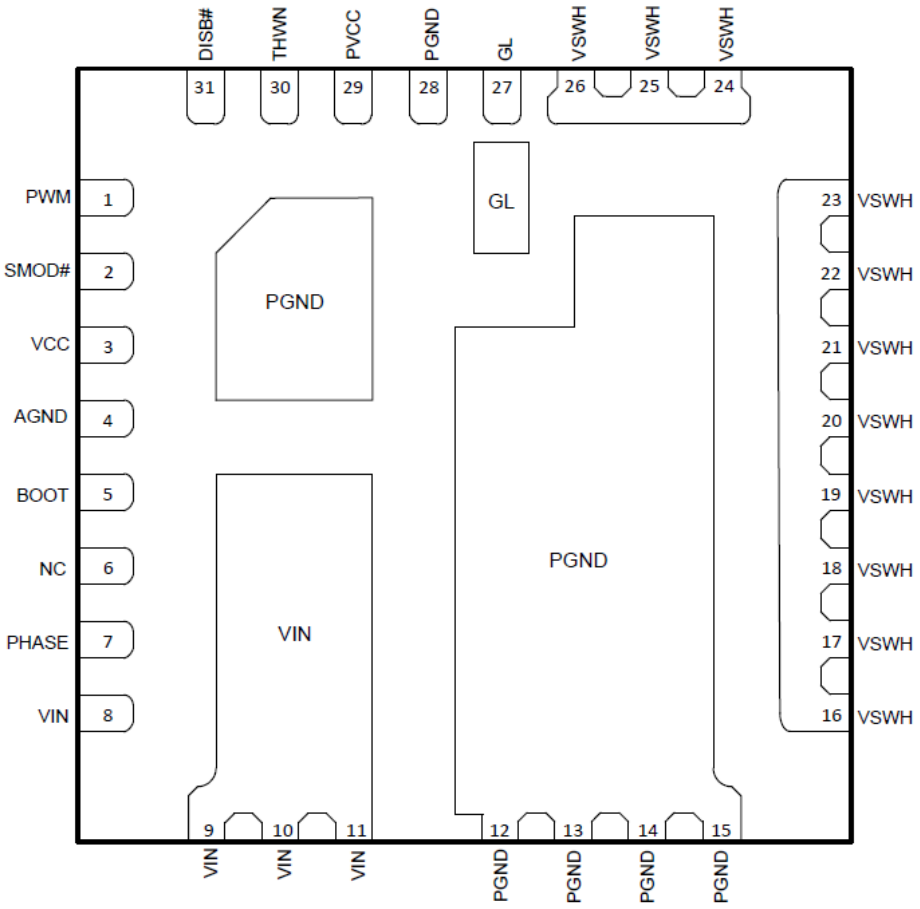
$\lambda$ = 0.460 $10^{-9}$ $hr^{-1}$ or 0.460 FIT; MTTF = (1/ λ) = 2,174.7 million hrs = 248,251 years

The calculation shows failure rate is 0.460 FIT, MTTF is 2,174.7 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%.




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