

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

**AOZ53267QI** rev A

**Plastic Encapsulated Device**

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The AOS product reliability report summarizes the qualification results for AOZ53267QI 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 AOZ53267QI 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                        | $T_J = 150^{\circ}\text{C}$ ,<br>$V_{IN} = 28\text{V}$                                                                     | 168 / 500 /<br>1000 hours | 231 pcs<br>(3 lots) | 0                  | JESD22-A108        |
| Preconditioning<br>(Note A) | $T_A = 85^{\circ}\text{C}$ , RH = 85% +<br>3 cycle reflow @ $260^{\circ}\text{C}$<br>(MSL 1)                               | 168 hours                 | 924 pcs<br>(3 lots) | 0                  | JESD22-A113        |
| HAST                        | $T_A = 130^{\circ}\text{C}$ , RH = 85%,<br>P = 33.3psia,<br>$V_{IN} = 30\text{V}$                                          | 96 hours                  | 231 pcs<br>(3 lots) | 0                  | JESD22-A110        |
| Autoclave                   | $T_A = 121^{\circ}\text{C}$ , RH = 100%, P<br>= 29.7psia                                                                   | 96 hours                  | 231 pcs<br>(3 lots) | 0                  | JESD22-A102        |
| Temperature<br>Cycle        | $T_A = -65^{\circ}\text{C}$ to $150^{\circ}\text{C}$ ,<br>air to air                                                       | 500 / 1000<br>cycles      | 231 pcs<br>(3 lots) | 0                  | JESD22-A104        |
| HTSL                        | $T_A = 150^{\circ}\text{C}$                                                                                                | 1000 hours                | 231 pcs<br>(3 lots) | 0                  | JESD22-A103        |
| Power Cycling               | $V_{IN} = 24\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $F_{SW}$<br>= 600kHz, $I_{OUT} = 22\text{A}$ , VCC<br>cycled 0V-5V @ 1hz | 24hrs, >86k<br>cycles     | 10 pcs<br>(3 lots)  | 0                  | AOS Standard       |
| HTGB<br>(MOSFET)            | $T_J = 150^{\circ}\text{C}$ ,<br>$V_{GS} = 12\text{V}$                                                                     | 168 / 500 /<br>1000 hours | 231<br>(3 lots)     | 0                  | JESD22-A108        |
| HTRB<br>(MOSFET)            | $T_J = 150^{\circ}\text{C}$ ,<br>$V_{DS} = 30\text{V}$                                                                     | 168 / 500 /<br>1000 hours | 231<br>(3 lots)     | 0                  | JESD22-A108        |
| H3TRB<br>(MOSFET)           | $T_A = 130^{\circ}\text{C}$ , RH = 85%,<br>P = 33.3psia,<br>$V_{DS} = 30\text{V}$                                          | 168 / 500 /<br>1000 hours | 231<br>(3 lots)     | 0                  | JESD22-A101        |
| Validation                  | 3 cycle reflow @ $260^{\circ}\text{C}$ +<br>250 cycles @ $T_A = -65^{\circ}\text{C}$ to<br>$150^{\circ}\text{C}$           | 250 cycles                | 3000<br>(3 lots)    | 0                  | AOS Standard       |
| Mechanical<br>Shock         | Condition B<br>a = 1500g; t = 0.5ms                                                                                        | 5 shocks /<br>side        | 30<br>(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:**  $V_o = 25V$ ,  $T_o = 55^\circ C$ ,  $V_{s(DriverIC)} = 28V$ ,  $V_{s(MOSFET)} = 30V$  and  $T_s = 150^\circ C$

**Sample Size:** MOSFET = 6,153, Driver IC = 3,874

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) :

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

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)

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

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

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

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

$\lambda = 0.460 \cdot 10^{-9} \text{ hr}^{-1}$  or 0.460 FIT; MTTF =  $(1/\lambda) = 2,174.7$  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     | $T_A = 25^{\circ}\text{C}$ , $\pm 2\text{kV}$                               | 10                | 0                  | JESD-A114          |
| Electrostatic Discharge Charged Device Model | $T_A = 25^{\circ}\text{C}$ , $\pm 1\text{kV}$                               | 10                | 0                  | JESD-C101          |
| Latch Up                                     | $T_A = 25^{\circ}\text{C}$ ,<br>$\pm 100\text{mA}$ , $1.5\times \text{OV}$  | 10                | 0                  | JESD78             |
| Latch Up                                     | $T_A = 125^{\circ}\text{C}$ ,<br>$\pm 100\text{mA}$ , $1.5\times \text{OV}$ | 10                | 0                  | JESD78             |

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

