

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

**AOZ13938DI-02**

rev A

**Plastic Encapsulated Device**

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The AOS product reliability report summarizes the qualification results for AOZ13938DI-02 in DFN3x3-12L 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 AOZ13938DI-02 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 <sub>J</sub> = 150°C, V <sub>IN</sub> = 32V	168 / 500 / 1000 hours	231 pcs (3 lots)	0	JESD22-A108
Preconditioning (Note A)	T <sub>A</sub> = 85°C, RH = 85% + 3 cycle reflow @ 260°C (MSL 1)	168 hours	924 pcs (3 lots)	0	JESD22-A113
HAST	T <sub>A</sub> = 130°C, RH = 85%, P = 33.3psia, V <sub>IN</sub> = 32V	96 hours	231 pcs (3 lots)	0	JESD22-A110
Pre-con + PCT (autoclave)	121°C , 29.7psia, RH=100%	96 hours	231 pcs (3 lots)	0	JESD22-A102
Temperature Cycle	T <sub>A</sub> = -65°C to 150°C, air to air	500 / 1000 cycles	231 pcs (3 lots)	0	JESD22-A104
HTSL	T <sub>A</sub> = 150°C	1000 hours	231 pcs (3 lots)	0	JESD22-A103
HTGB (MOSFET)	T <sub>J</sub> = 150°C, V <sub>GS</sub> = 10V	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A108
HTRB (MOSFET)	T <sub>J</sub> = 150°C, V <sub>DS</sub> = 39V	168 / 500 / 1000 hours	231 (3 lots)	0	JESD22-A108
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**

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

$$\lambda = \chi^2[CL, (2f+2)] / 2 \times [1 / (SS \times t \times AF)]; \text{ [equation 1]}$$

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) :

$AF = AF_T \times AF_V = \exp[(E_a/k) \times (1/T_o - 1/T_s)] \times \exp[\beta (V_s - V_o)]$  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  
 $\beta$  = voltage acceleration coefficient

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  $\lambda = 2 \cdot \lambda(MOSFET) + \lambda(DriverIC) =$

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

$\lambda = 0.460 \cdot 10^{-9} hr^{-1}$  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.

# ELECTROSTATIC DISCHARGE, LATCH UP TEST REPORT

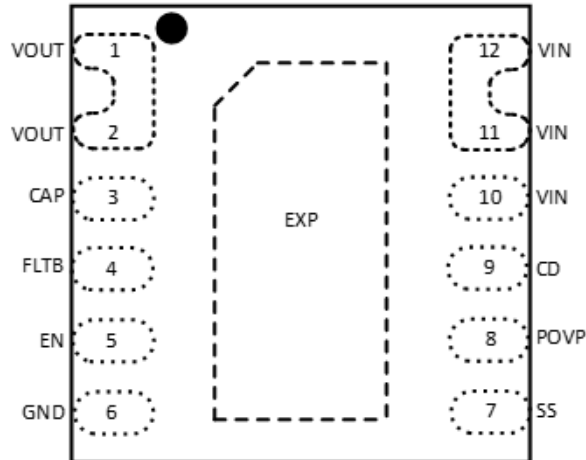
Part Number: AOZ13938DI-02

Package: DFN3x3\_12L

ESD, LATCH UP RESULTS					
Test	Specification	Conditions	Temperature	Sample Size	Results <sup>(2)</sup>
Electrostatic Discharge	JESD-A114	±2.5kV (HBM)	25C	3	PASS
Electrostatic Discharge	JESD-C101	±1kV (CDM)	25C	3	PASS
Latch Up	JESD78	±100mA, 1.5x OV	25C	6	PASS <sup>(1)</sup>
Latch Up	JESD78	±100mA, 1.5x OV	125C	6	PASS <sup>(1)</sup>

**Note:**

1. CAP pin Current Inject ±20mA and FLTB pin Current Inject ±50mA, Immunity Level B
2. ATE results are used to determine PASS/FAIL. Parametric shift <10%.

**Pin Configuration**


**DFN3x3-12L**  
(Top Transparent View)