

AOS Semiconductor Product Reliability Report

AOZ1390DI-02 rev A

Plastic Encapsulated Device

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The AOS product reliability report summarizes the qualification results for AOZ1390DI-02 in DFN3.5X3-14L 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 AOZ1390DI-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. AOZ1390DI-02 Full Reliability Stress Test Results

Test Item	Test Condition	Time Point	Sample Size / Lots	Number of Failures	Reference Standard
HTOL	$T_J = 125^{\circ}\text{C}$, $V_{IN} = 22\text{V}$	168 hours	231 pcs (3 lots)	0	JESD22-A108
		500 hours		0	
		1000 hours		0	
Preconditioning (Note A)	$T_A = 30^{\circ}\text{C}$, RH = 60% + 3 cycle reflow @ 260°C (MSL 3)	192 hours	924 pcs (3 lots)	0	JESD22-A113
HAST	$T_A = 130^{\circ}\text{C}$, RH = 85%, $P = 33.3\text{psia}$, $V_{IN} = 22\text{V}$	96 hours	231 pcs (3 lots)	0	JESD22-A110
Temperature Cycle	$T_A = -65^{\circ}\text{C}$ to 150°C , air to air	500 cycles	231 pcs (3 lots)	0	JESD22-A104
		1000 cycles		0	
HTSL	$T_A = 150^{\circ}\text{C}$	1000 hours	231 pcs (3 lots)	0	JESD22-A103
Autoclave	$T_A = 121^{\circ}\text{C}$, RH = 100%, $P = 29.7\text{psia}$	96 hours	231 pcs (3 lots)	0	JESD22-A102
HTGB (MOSFET)	$T_J = 150^{\circ}\text{C}$, $V_{GS} = 12\text{V}$	168 hours	231 (3 lots)	0	JESD22-A108
		500 hours			
HTRB (MOSFET)	$T_J = 150^{\circ}\text{C}$, $V_{DS} = 30\text{V}$	168 hours	231 (3 lots)	0	JESD22-A108
		500 hours			

Note: The reliability data presents total of available generic data up to the published date.

Note A: MSL (Moisture Sensitivity Level) 3 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): 0.216

MTTF = 4621.6 million hrs

Condition: $V_o = 14V$, $T_o = 55^\circ C$, $V_{s(IC)} = 22V$, $V_{s(MOSFET)} = 30V$, $T_{s(IC)} = 125^\circ C$ and $T_{s(MOSFET)} = 150^\circ C$

Sample Size: MOSFET = 6,153, IC = 640

The failure rate (λ) 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, $V_o = 14V$, $T_o = 55^\circ C$, $E_a = 0.7eV$, $V_{s(IC)} = 22V$, $V_{s(MOSFET)} = 30V$, $T_{s(IC)} = 125^\circ C$ and $T_{s(MOSFET)} = 150^\circ C$, $\beta = 0.5$ (silicon defect)

$$AF(DriverIC) = \exp \left[\left(\frac{0.7}{8.617E - 5} \right) \cdot \left(\frac{1}{273 + 55} - \frac{1}{273 + 125} \right) \right] \cdot \exp[0.5 \cdot (22V - 14V)]$$

$$AF(MOSFET) = \exp \left[\left(\frac{0.7}{8.617E - 5} \right) \cdot \left(\frac{1}{273 + 55} - \frac{1}{273 + 150} \right) \right] \cdot \exp[0.5 \cdot (30V - 14V)]$$

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

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

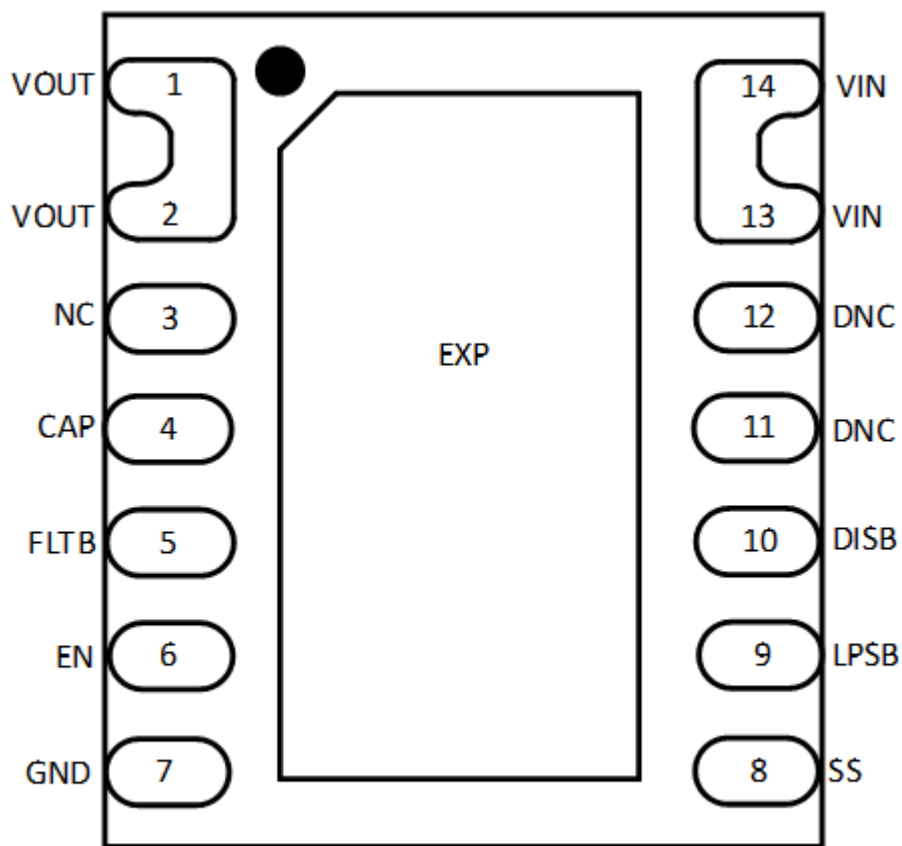
$$\lambda = 0.216 \cdot 10^{-9} \text{ hr}^{-1} \text{ or } 0.216 \text{ FIT}; \text{ MTTF} = (1 / \lambda) = 4621.6 \text{ million hrs} = 527577 \text{ years}$$

The calculation shows failure rate is 0.216 FIT, MTTF is 4621.6 million hours under typical operating conditions.

III. AOZ1390DI-02 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	$T_A = 25^{\circ}\text{C}$, $\pm 100\text{mA}$, $1.27\times \text{OV}$	10	0	JESD78
Latch Up	$T_A = 125^{\circ}\text{C}$, $\pm 100\text{mA}$, $1.27\times \text{OV}$	10	0	JESD78

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



DFN3x3.5-14L
(Top Transparent View)