



Reliability Report

Report Title: AD7401A 8YZ10A & 8YL58A Auto Grade 1 at ADLK Fab Qualification

Report Number: 20822

Revision: A

Date: 21 February 2024

Summary

This report documents the successful completion of the reliability qualification requirements for the release of the AD7401A product in a 16-SOIC_W package. Both of its dice are fabricated respectively at the 0.5um CMOS Wafer Fabrication Facility and 0.6um CMOS Wafer Fabrication Facility of ADI-Limerick. One of the dice also gets its post passivation Isolation from the Isolation Fabrication Process also at ADI-Limerick.

The AD7401A is a second-order, sigma-delta (Σ - Δ) modulator that converts an analog input signal into a high speed, 1-bit data stream with on-chip digital isolation based on the Analog Devices, Inc., iCoupler® technology. The AD7401A operates from a 5 V power supply and accepts a pseudo-differential input signal of ± 250 mV (± 320 mV full scale).

AECQ100 Qualification Test Methods and Summary

| AEC Test Group | AEC Stress Test Name | Abbreviation | AEC Test# | Reference |
|---|---|----------------------|-----------|---|
| Group A ACCELERATED ENVIRONMENT STRESS TESTS | Preconditioning | PC | A1 | Table 2, and Table 4 |
| | Temperature Humidity Bias or Biased-HAST | THB or HAST | A2 | |
| | Autoclave or Unbiased HAST or Temperature Humidity (without Bias) | AC, UHST, or TH | A3 | |
| | Temperature Cycle | TC | A4 | |
| | Power Temperature Cycling | PTC | A5 | |
| | High Temperature Storage Life | HTSL | A6 | |
| Group B ACCELERATED LIFETIME SIMULATION TESTS | High Temperature Operating Life | HTOL | B1 | Table 2, and Table 4 |
| | Early Life Failure Rate | ELFR | B2 | |
| | NVM Endurance, Data Retention, and Operational Life | EDR | B3 | |
| Group C PACKAGE ASSEMBLY INTEGRITY TESTS | Wire Bond Shear | WBS | C1 | <ul style="list-style-type: none"> • Test C2 (and C1 for Cu Wire) are shown in Table 4. • Tests C3-6 are qualified and controlled with inline monitors and may be viewed on-site at Analog Devices. |
| | Wire Bond Pull Strength | WBP | C2 | |
| | Solderability | SD | C3 | |
| | Physical Dimensions | PD | C4 | |
| | Solder Ball Shear | SBS | C5 | |
| | Lead Integrity | LI | C6 | |
| Group D DIE FABRICATION RELIABILITY TESTS | Electromigration | EM | D1 | Die Fabrication Reliability data may be viewed on-site at Analog Devices. |
| | Time Dependent Dielectric Breakdown | TDDDB | D2 | |
| | Hot Carrier Injection | HCI | D3 | |
| | Negative Bias Temperature Instability | BTI | D4 | |
| | Stress Migration | SM | D5 | |
| Group E ELECTRICAL VERIFICATION TESTS | Pre- and Post-Stress Electrical Test | TEST | E1 | Table 5, and Table 6 |
| | Electrostatic Discharge Human Body Model | HBM | E2 | |
| | Electrostatic Discharge Charged Device Model | CDM | E3 | |
| | Latch-Up | LU | E4 | |
| | Electrical Distributions | ED | E5 | <ul style="list-style-type: none"> • For Tests E5, E6 and E7, ADI New Product Yield Analysis Testing Guidelines meet AEC Q100 requirements. • Results for Tests E7-E11 are available as applicable on a case-by-case basis. • Test E12 results may be viewed on-site at Analog Devices |
| | Fault Grading | FG | E6 | |
| | Characterization | CHAR | E7 | |
| | Electromagnetic Compatibility | EMC | E9 | |
| | Short Circuit Characterization | SC | E10 | |
| | Soft Error Rate | SER | E11 | |
| | Lead (Pb) Free | LF | E12 | |
| | Group F DEFECT SCREENING TESTS | Process Average Test | PAT | |
| Statistical Bin/Yield Analysis | | SBA | F2 | |
| Group G CAVITY PACKAGE INTEGRITY TESTS | Mechanical Shock | MS | G1 | < Applicable only for Cavity-Packages > |
| | Variable Frequency Vibration | VFV | G2 | |
| | Constant Acceleration | CA | G3 | |
| | Gross/Fine Leak | GFL | G4 | |
| | Package Drop | DROP | G5 | |
| | Lid Torque | LT | G6 | |
| | Die Shear | DS | G7 | |
| | Internal Water Vapor | IWV | G8 | |

Die/Fab Product Characteristics

Table 1.1: Die/Fab Product Characteristics- 0.5um CMOS

| Product Characteristics | Product(s) to be qualified |
|---------------------------|----------------------------|
| Generic/Root Part # | AD7401A / 8YZ10A |
| Die Id | 8YZ10 A |
| Die Size (mm) | 1.51 x 2.9 |
| Wafer Fabrication Site | ADI-Limerick |
| Wafer Fabrication Process | 0.5um CMOS |
| Die Substrate | Si |
| Metallization / # Layers | AlCu(0.5%)/3 |
| Polyimide | No |
| Passivation | undoped-oxide/SiN |

Table 1.2: Die/Fab Product Characteristics- 0.6um CMOS

| Product Characteristics | Product(s) to be qualified |
|---------------------------|----------------------------------|
| Generic/Root Part # | AD7400TC/D / 8YL58A |
| Die Id | 8YL58A |
| Die Size (mm) | 1.5 x 2.87 |
| Wafer Fabrication Site | ADI-Limerick |
| Wafer Fabrication Process | 0.6um CMOS |
| Die Substrate | Si |
| Metallization / # Layers | AlCu(0.5%) and 100% Au on Coil/3 |
| Polyimide | No |
| Passivation | undoped-oxide/SiN |

Table 1.3: Die/Fab Product Characteristics- Isolation

| Product Characteristics | Product(s) to be qualified |
|---------------------------|----------------------------------|
| Generic/Root Part # | AD7400TC/D / 8YL58A |
| Die Id | 8YL58A |
| Die Size (mm) | 1.5 x 2.87 |
| Wafer Fabrication Site | ADI-Limerick |
| Wafer Fabrication Process | Isolation |
| Die Substrate | Si |
| Metallization / # Layers | AlCu(0.5%) and 100% Au on Coil/0 |
| Polyimide | Yes |
| Passivation | undoped-oxide/SiN |

Die/Fab Test Results

Table 2.1: Die/Fab Test Results - 0.5um CMOS at ADI-Limerick

| Test Name | AEC # | Spec | Conditions | Generic/Root Part # | Lot # | Fail/SS | eTest Temp |
|---|-------|-------------|--|---------------------|-----------------------|---------|------------|
| High Temperature Storage Life (HTSL) | A6 | JESD22-A103 | 150°C, 1,000 Hours | AD7401A | Q20822.1.HS3_RES_EXP | 0/77 | RH |
| Highly Accelerated Temperature and Humidity Stress Test (HAST) ¹ | A2 | JESD22-A110 | 130C 85%RH 33.3 psia, Biased, 96 Hours | AD7401A | Q20822.1.HA1_RES_EXP | 0/77 | RH |
| | | | | | Q20822.2.HA2_RES_EXP | 0/77 | RH |
| | | | | | Q20822.3.HA3_RES_EXP | 0/77 | RH |
| Temperature Cycling (TC) ¹ | A4 | JESD22-A104 | -65°C/+150°C, 500 Cycles | AD7401A | Q20822.1.TC3_RES_EXP | 0/77 | H |
| | | | | | Q20822.2.TC2_RES_EXP | 0/77 | H |
| | | | | | Q20822.3.TC1_RES_EXP | 0/77 | H |
| Unbiased HAST (UHST) ¹ | A3 | JESD22-A118 | 130C 85%RH 33.3 psia, 96 Hours | AD7401A | Q20822.1.UH3_RES_EXP | 0/77 | R |
| | | | | | Q20822.2.UH2_RES_EXP | 0/77 | R |
| | | | | | Q20822.3.UH1_RES_EXP | 0/77 | R |
| High Temperature Operating Life (HTOL) ¹ | B1 | JESD22-A108 | 125°C<Tj<135°C, Biased, 500 Hours | AD7401A | Q20822.3.HO1_RES_EXP | 0/77 | RHC |
| | | | | | Q20822.2.HO2_RES_EXP | 0/77 | RHC |
| High Temperature Operating Life (HTOL) ¹ | B1 | JESD22-A108 | 125°C<Tj<135°C, Biased, 1000 Hours | AD7401A | Q20822.1.HO3_RES_EXP | 0/77 | RHC |
| Early Life Failure Rate (ELFR) | B2 | JESD22- | 125°C, 48 Hours | AD2S1210 | Q20663.1.EL1A_RES_EXP | 0/800 | RH |
| | | A108 / | | | Q20663.2.EL2A_RES_EXP | 0/800 | RH |
| | | JESD74 | | | Q20663.3.EL3A_RES_EXP | 0/800 | RH |

¹ These samples were subjected to preconditioning at MSL 3 with 3x reflow peak temp of 260°C prior to the start of the stress test.

Table 2.2: Die/Fab Test Results - Isolation at ADI-Limerick

| Test Name | AEC # | Spec | Conditions | Generic/Root Part # | Lot # | Fail/SS | eTest Temp |
|---|-------|-------------|--|---------------------|----------------------|---------|------------|
| High Temperature Storage Life (HTSL) | A6 | JESD22-A103 | 150°C, 1,000 Hours | AD7401A | Q20822.1.HS3_RES_EXP | 0/77 | RH |
| Highly Accelerated Temperature and Humidity Stress Test (HAST) ¹ | A2 | JESD22-A110 | 130C 85%RH 33.3 psia, Biased, 96 Hours | AD7401A | Q20822.1.HA1_RES_EXP | 0/77 | RH |
| | | | | | Q20822.2.HA2_RES_EXP | 0/77 | RH |
| | | | | | Q20822.3.HA3_RES_EXP | 0/77 | RH |
| Temperature Cycling (TC) ¹ | A4 | JESD22-A104 | -65°C/+150°C, 500 Cycles | AD7401A | Q20822.1.TC3_RES_EXP | 0/77 | H |
| | | | | | Q20822.2.TC2_RES_EXP | 0/77 | H |
| | | | | | Q20822.3.TC1_RES_EXP | 0/77 | H |
| Unbiased HAST (UHST) ¹ | A3 | JESD22-A118 | 130C 85%RH 33.3 psia, 96 Hours | AD7401A | Q20822.1.UH3_RES_EXP | 0/77 | R |
| | | | | | Q20822.2.UH2_RES_EXP | 0/77 | R |
| | | | | | Q20822.3.UH1_RES_EXP | 0/77 | R |
| High Temperature Operating Life (HTOL) ¹ | B1 | JESD22-A108 | 125°C<Tj<135°C, Biased, 500 Hours | AD7401A | Q20822.3.HO1_RES_EXP | 0/77 | RHC |
| | | | | | Q20822.2.HO2_RES_EXP | 0/77 | RHC |
| High Temperature Operating Life (HTOL) ¹ | B1 | JESD22-A108 | 125°C<Tj<135°C, Biased, 1000 Hours | AD7401A | Q20822.1.HO3_RES_EXP | 0/77 | RHC |
| Early Life Failure Rate (ELFR) | B2 | AEC- | 125°C, 48 Hours | ADUM1201W | Q11159.EL1 | 0/800 | RH |
| | | Q100- | | | Q11159.EL2 | 0/800 | RH |
| | | 008 | | | Q11159.EL3 | 0/800 | RH |

¹ These samples were subjected to preconditioning at MSL 3 with 3x reflow peak temp of 260°C prior to the start of the stress test.

Table 2.3: Die/Fab Test Results - 0.6um CMOS at ADI-Limerick

| Test Name | AEC # | Spec | Conditions | Generic/Root Part # | Lot # | Fail/SS | eTest Temp |
|---|-------|-------------|--|---------------------|----------------------|---------|------------|
| High Temperature Storage Life (HTSL) | A6 | JESD22-A103 | 150°C, 1,000 Hours | AD7401A | Q20822.1.HS3_RES_EXP | 0/77 | RH |
| Highly Accelerated Temperature and Humidity Stress Test (HAST) ¹ | A2 | JESD22-A110 | 130C 85%RH 33.3 psia, Biased, 96 Hours | AD7401A | Q20822.1.HA1_RES_EXP | 0/77 | RH |
| | | | | | Q20822.2.HA2_RES_EXP | 0/77 | RH |
| | | | | | Q20822.3.HA3_RES_EXP | 0/77 | RH |
| Temperature Cycling (TC) ¹ | A4 | JESD22-A104 | -65°C/+150°C, 500 Cycles | AD7401A | Q20822.1.TC3_RES_EXP | 0/77 | H |
| | | | | | Q20822.2.TC2_RES_EXP | 0/77 | H |
| | | | | | Q20822.3.TC1_RES_EXP | 0/77 | H |
| Unbiased HAST (UHST) ¹ | A3 | JESD22-A118 | 130C 85%RH 33.3 psia, 96 Hours | AD7401A | Q20822.1.UH3_RES_EXP | 0/77 | R |
| | | | | | Q20822.2.UH2_RES_EXP | 0/77 | R |
| | | | | | Q20822.3.UH1_RES_EXP | 0/77 | R |
| High Temperature Operating Life (HTOL) ¹ | B1 | JESD22-A108 | 125°C<Tj<135°C, Biased, 500 Hours | AD7401A | Q20822.3.HO1_RES_EXP | 0/77 | RHC |
| | | | | | Q20822.2.HO2_RES_EXP | 0/77 | RHC |
| High Temperature Operating Life (HTOL) ¹ | B1 | JESD22-A108 | 125°C<Tj<135°C, Biased, 1000 Hours | AD7401A | Q20822.1.HO3_RES_EXP | 0/77 | RHC |
| Early Life Failure Rate (ELFR) | B2 | AEC- | 125°C, 48 Hours | ADUM1201W | Q11159.EL1 | 0/800 | RH |
| | | Q100- | | | Q11159.EL2 | 0/800 | RH |
| | | 008 | | | Q11159.EL3 | 0/800 | RH |

¹ These samples were subjected to preconditioning at MSL 3 with 3x reflow peak temp of 260°C prior to the start of the stress test.

Package/Assembly Product Characteristics

Table 3: Package/Assembly Product Characteristics - 16-SOIC_W at ASE (AET)

| Product Characteristics | Product(s) to be qualified |
|------------------------------------|-------------------------------|
| Generic/Root Part # | AD7401A |
| Package | 16-SOIC_W |
| Body Size (mm) | 10.50 x 7.60 x 2.35 |
| Assembly Location | ASE (AET) |
| MSL/Peak Reflow Temperature(°C) | 3 / 260°C |
| Mold Compound | Sumitomo G700LY |
| Die Attach | Ablestik 2025D non-conductive |
| Leadframe Material | Copper |
| Lead Finish | 100Sn |
| Wire Bond Material/Diameter (mils) | Heraeus AW7 4N Gold / 1.30 |

Package/Assembly Test Results

Table 4: Package/Assembly Test Results - SOIC_W at ASE (AET)

| Test Name | AEC # | Spec | Conditions | Generic/Root Part # | Lot # | Fail/SS | eTest Temp |
|---|-------|-------------|--|---------------------|------------------------|---------|------------|
| High Temperature Storage Life (HTSL) | A6 | JESD22-A103 | 150°C, 1,000 Hours | AD7401A | Q20822.1.HS3_RES_EXP | 0/77 | RH |
| Highly Accelerated Temperature and Humidity Stress Test (HAST) ¹ | A2 | JESD22-A110 | 130C 85%RH 33.3 psia, Biased, 96 Hours | AD7401A | Q20822.1.HA1_RES_EXP | 0/77 | RH |
| | | | | | Q20822.2.HA2_RES_EXP | 0/77 | RH |
| | | | | | Q20822.3.HA3_RES_EXP | 0/77 | RH |
| Solder Heat Resistance (SHR) | A1 | J-STD-020 | MSL-3 | AD7401A | Q20822.1.SH3_RES_EXP | 0/11 | R |
| | | | | | Q20822.2.SH2_RES_EXP | 0/11 | R |
| | | | | | Q20822.3.SH1_RES_EXP | 0/11 | R |
| Temperature Cycling (TC) ¹ | A4 | JESD22-A104 | -65°C/+150°C, 500 Cycles | AD7401A | Q20822.1.TC3_RES_EXP | 0/77 | H |
| | | | | | Q20822.2.TC2_RES_EXP | 0/77 | H |
| | | | | | Q20822.3.TC1_RES_EXP | 0/77 | H |
| Unbiased HAST (UHST) ¹ | A3 | JESD22-A118 | 130C 85%RH 33.3 psia, 96 Hours | AD7401A | Q20822.1.UH3_RES_EXP | 0/77 | R |
| | | | | | Q20822.2.UH2_RES_EXP | 0/77 | R |
| | | | | | Q20822.3.UH1_RES_EXP | 0/77 | R |
| Wire Bond Pull – Post TC | C2 | AEC-Q003 | 3 gF | AD7401A | Q20822.1.WPPT1_RES_EXP | 0/5 | NA |

¹ These samples were subjected to preconditioning at MSL 3 with 3x reflow peak temp of 260°C prior to the start of the stress test.

ESD and Latch-Up Test Results

Table 5: ESD Test Result

| ESD Model | Generic/Root Part # | Package | ESD Test Spec | RC Network | Highest Pass Level | Class | eTest Temp |
|-----------|---------------------|-----------|---------------|--------------|--------------------|-------|------------|
| FICDM | AD7401A | 16-SOIC_W | AEC-Q100-011 | 1Ω, Cpkg | ±1250V | C3 | RH |
| HBM | AD7401A | 16-SOIC_W | AEC-Q100-002 | 1.5kΩ, 100pF | ±3000V | 2 | RH |

Table 6: Latch Up Test Result

| LU Test Spec | Generic/Root Part # | Passing Current | Passing Over-Voltage | Temperature (T _A) | Class | eTest Temp |
|--------------|---------------------|-----------------|----------------------|-------------------------------|-------|------------|
| JESD78 | AD7401A | +200mA, -200mA | + 8.25V, 8.25V | 125°C | II | RH |

Approvals

Reliability Engineer: Danilo Juinio Jr.

Appendix

| PCL-6360_AD7401A_Q20822.1.WPPT1_RES_EXP_AY24349.19 | | | | | | | | | | |
|--|-------|------|-------|------|-------|------|-------|------|-------|------|
| Name: Carl Genido | | | | | | | | | | |
| Date performed: 2/28/2024 | | | | | | | | | | |
| Time Start: 2230 | | | | | | | | | | |
| Time End: 2345 | | | | | | | | | | |
| Unit | 1 | | 2 | | 3 | | 4 | | 5 | |
| Ball | Pull | Mode | Pull | Mode | Pull | Mode | Pull | Mode | Pull | Mode |
| 1 | 15.84 | a-1 | 16.48 | a-1 | 17.23 | a-1 | 17.07 | a-1 | 16.61 | a-1 |
| 2 | 15.51 | a-1 | 14.97 | a-1 | 15.34 | a-1 | 15.95 | a-1 | 15.24 | a-1 |
| 3 | 18.85 | a-1 | 17.51 | a-1 | 17.47 | a-1 | 19.2 | a-1 | 16.35 | a-1 |
| 4 | 13.72 | a-1 | 15.70 | a-1 | 14.82 | a-1 | 15.41 | a-1 | 14.20 | a-1 |
| 5 | 15.56 | a-1 | 16.30 | a-1 | 15.38 | a-1 | 14.78 | a-1 | 15.71 | a-1 |
| 6 | 19.71 | a-1 | 19.30 | a-1 | 17.34 | a-1 | 18.34 | a-1 | 17.73 | a-1 |
| 7 | 17.70 | a-1 | 19.15 | a-1 | 19.41 | a-1 | 18.04 | a-1 | 18.23 | a-1 |
| 8 | 16.05 | a-1 | 16.07 | a-1 | 16.67 | a-1 | 16.73 | a-1 | 16.78 | a-1 |
| 9 | 15.22 | a-1 | 15.33 | a-1 | 14.69 | a-1 | 15.03 | a-1 | 15.39 | a-1 |
| 10 | 13.91 | a-1 | 13.93 | a-1 | 14.89 | a-1 | 14.31 | a-1 | 13.69 | a-1 |
| 11 | 15.01 | a-1 | 14.68 | a-1 | 14.65 | a-1 | 15.08 | a-1 | 15.09 | a-1 |
| 12 | 16.14 | a-1 | 17.30 | a-1 | 17.93 | a-1 | 18.17 | a-1 | 17.48 | a-1 |
| MIN | 13.72 | | 13.93 | | 14.65 | | 14.31 | | 13.69 | |
| MAX | 19.71 | | 19.30 | | 19.41 | | 19.20 | | 18.23 | |
| AVE | 16.10 | | 16.39 | | 16.32 | | 16.51 | | 16.04 | |
| STDEV | 1.82 | | 1.68 | | 1.57 | | 1.64 | | 1.40 | |