Reliability Report

DAC39RF10-SP Production Flow and Reliability Report

ABSTRACT

This report presents the reliability and qualification results for the DAC39RF10-SP (Radiation-hardness-assured (RHA), 300-krad, 16-bit, 2-channel, 10.4-GSPS or 20.8-GSPS digital-to-analog converter). The DAC39RF10-SP is manufactured with a controlled baseline and has the following guarantees compared to commercial-grade devices:

- An extended product life cycle
- One wafer-fab, assembly and test site
- Product traceability
- Radiation lot-acceptance testing

Table of Contents

1 Texas Instruments Product Qualification and Reliability Report....2
2 Space Grade MLS Production Flow....2
3 Device Qualification....4
4 Outgas Test Report....5
5 Construction Exceptions and Manufacturing Flow Optimizations....6

Trademarks

All trademarks are the property of their respective owners.

Copyright © 2026 Texas Instruments Incorporated

1 Texas Instruments Product Qualification and Reliability Report

TI qualification testing is a risk mitigation process that is engineered to verify device longevity in customer applications. Wafer fabrication process and package level reliability are evaluated in a variety of ways that can include accelerated environmental test conditions with subsequent derating to actual use conditions.

Manufacturability of the device is evaluated to verify a robust assembly flow and maintain continuity of supply to customers. TI Enhanced Products are qualified with industry standard test methodologies performed to the intent of Joint Electron Devices Engineering Council (JEDEC) standards and procedures. Texas Instruments Enhanced Products are certified to meet GEIA-STD-0002-1 Aerospace Qualified Electronic Components.

2 Space Grade MLS Production Flow

Device Introduction

DAC39RF10-SP is a radiation hardened device in a plastic flip-chip package that is suitable for space applications. The 17 × 17mm 256ACL package utilizes internal lead-free die-bumps (with underfill) and eutectic tin-lead external BGA balls.

The device was verified immune to 120 MeV·cm2/mg at 125°C for single event latch-up (SEL). Each fabrication lot is tested according to MIL-STD-883 for Radiation Lot Acceptance Tested (RLAT) up to 300 krad(Si) and each assembly and test lot follows the process flow shown in Figure 2-1. To maintain the quality and reliability of DAC39RF10-SP, it has been tested and qualified to meet space-grade requirements. See Section 3 for further details.

Copyright © 2026 Texas Instruments Incorporated

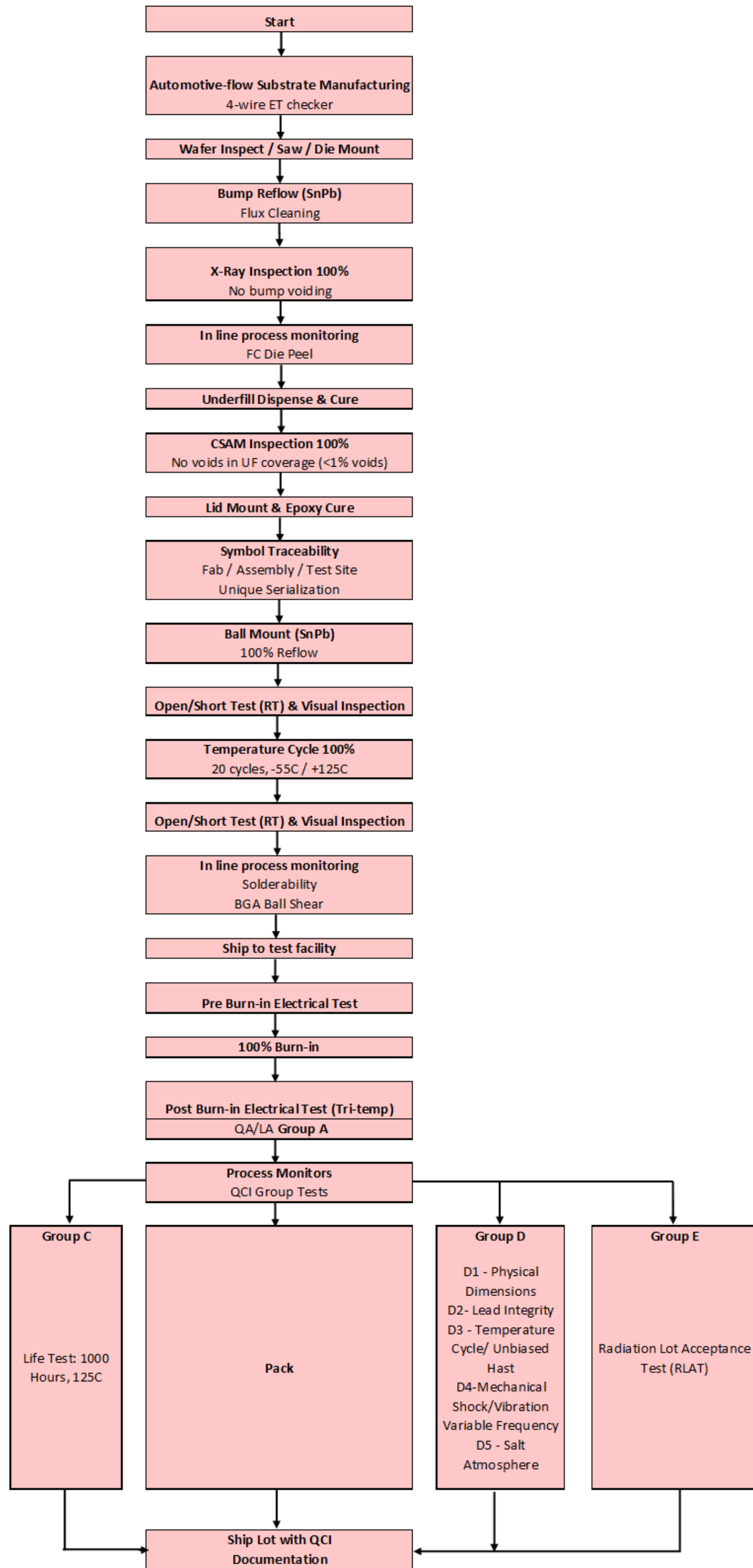

Figure 2-1. DAC39RF10-SP Screening Flow

Copyright © 2026 Texas Instruments Incorporated

3 Device Qualification

The following is the device qualification summary.

Qualification by Similarity (Qualification Family)

A new device can be qualified either by performing full-scale quality and reliability tests on the actual device or using previously qualified devices through qualification by similarity (QBS) rules. By establishing similarity between the new device and those qualified previously, repetitive tests are eliminated, allowing for timely production release. When adopting QBS methodology, the emphasis is on qualifying the differences between a previously qualified product and the new product under consideration.

The QBS rules for a technology, product, test parameters or package shall define which attributes are required to remain fixed for the QBS rules to apply. The attributes which are expected and allowed to vary are reviewed and a QBS plan shall be developed, based on the reliability impact assessment above, specifying what subset of the full complement of environmental stresses is required to evaluate the reliability impact of those variations. Each new device shall be reviewed for conformance to the QBS rule sets applicable to that device.

See JEDEC JESD47 for more information.

Table 3-1. Device Overview

TI Device	DAC39RF10ACL-MLS	**Assembly Site**	AMKOR (KOREA)
Wafer Fab	TSMC F12	**Test Site**	TI-PHI (Phillipines)
Fab Process	TSMC C014.P CMOS 40nm	**Pin and Package type**	ACL, 256
Fab Technology	TSMC C014.P CMOS 40nm	**Substrate Bump Finish**	Pb Free SOP/uBall
Die Revision	B	**Substrate Pad Finish**	SnAgCu
ESD CDM	±250V	**Chip Cap Termination**	Pure Sn
ESD HBM	±1000V	**Moisture Sensitivity**	MSL 3/ 220°C

Copyright © 2026 Texas Instruments Incorporated

Table 3-2. Space Products New Device Qualification Matrix

Req name	Method / Conditions	Lots / Devices	SS / Accept
Precon MSL3	MSL3 220°C	3	120/0
UHAST (110°C)	110C/85%RH, 264, 528 Hours	3	30/0
BHAST (110°C)	110C/85%RH, 264, 528 Hours	3	30/0
HTSL (150°C)	150C, 1000 Hours	3	30/0
Temperature Cycle	-55C/125C, 1000 cycles	3	30/0
Solderability	22 leads/lot, min 3 devices. 245C + 5C Condition A (steam age for 8 hours)	1	3/0
Physical Dimensions	Per case outline drawing	1	15/0
D3 per QCI plan	Precon MSL3, 220C b) JESD22-A104, -55/125C, 1000 cycles c) JESD22-A118, 110C/85%RH, 264 hours	1	15/0
D4 per QCI plan	Per MIL-PRF-38535M Table V	1	15/0
D5 Salt Atmosphere, per QCI plan	Condition A, per 883 TM1009	1	15/0
ESD CDM	JS-002, 250V	1	3/0
ESD HBM	JS-001, 1KV	1	3/0
Latch-Up HT	JESD78, 150C	1	3/0
C1 - Life Test, 125°C	TM1005 125C, 1000 Hours	1	45/0
Outgassing Characterization	ASTM E595 TML <=1% CVCM <=0.1%	-	PASS
Thermal Resistance QML	Simulation	-	See Data sheet / Complete
Radiation Response Characterization	Total ionization dose, single-event latch-up MIL-STD-883/Method 1019	1	Complete (Refer to radiation report on www.ti.com)

4 Outgas Test Report

Outgassing test was performed on the DAC39RF10-SP bill-of-materials. A total mass loss (TML) of 1.00% and collected volatile condensable material (CVCM) of 0.10% were used as screening levels for rejection of spacecraft materials. The outgas test was performed in a vacuum environment of less than 5 × 10E–5 torr according to ASTM E 595, for a duration of 24 hours, at 125°C. The TML and CVCM were measured after the test.

Table 4-1. Outgas Test Results

Material	TML 1%	CVCM < 0.1%
Underfill	PASS	PASS
Substrate	PASS	PASS
TIM	PASS	PASS

Copyright © 2026 Texas Instruments Incorporated

5 Construction Exceptions and Manufacturing Flow Optimizations

Table 5-1. Construction Exceptions and Manufacturing Flow Optimizations

MIL-PRF-38535 Item	Construction and Exception
Eutectic SnPb solder bumps	Pb-free internal solder bumps encapsulated with underfill
Chip Caps termination	32 Chip caps with pure-Sn termination not encapsulated
WLR	Thermal Stability not Performed by TSMC FAB
TID	Per TM 1019 Condition A

TI performed a single-lot Sn-whisker study on the DAC39RF10-SP 256ACL package with the following conditions:

REL TEST	CONDITION	SAMPLE SIZE	RESULT
Temperature Cycling	-55/85 C, 1500 cycles	1 lot, 3u/lot, 32 cap/unit, total 192 terminations	100% passed electrical testing. No whisker detected based on 100X optical inspection.
Unbiased Temperature Humidity Low	30C / 60%, 4000 Hours	1 lot, 3u/lot, 32 cap/unit, total 192 terminations	100% passed electrical testing. No whisker detected based on 100X optical inspection.
Unbiased Temperature Humidity High	55C / 85%, 4000 Hours	1 lot, 3u/lot, 32 cap/unit, total 192 terminations	100% passed electrical testing. No whisker detected based on 100X optical inspection.

Copyright © 2026 Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale, TI's General Quality Guidelines, or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2026, Texas Instruments Incorporated

Last updated 10/2025