



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 features compared to commercial-grade devices:

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

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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 designed for space applications. The 17mm × 17mm 256ACL package utilizes internal lead-free die bumps (with underfill) and eutectic tin-lead external BGA balls.

The device was verified immune to 120MeV·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 testing (RLAT) up to 300krad(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, the device has been tested and qualified to meet space-grade requirements. See Section 3 for further details.

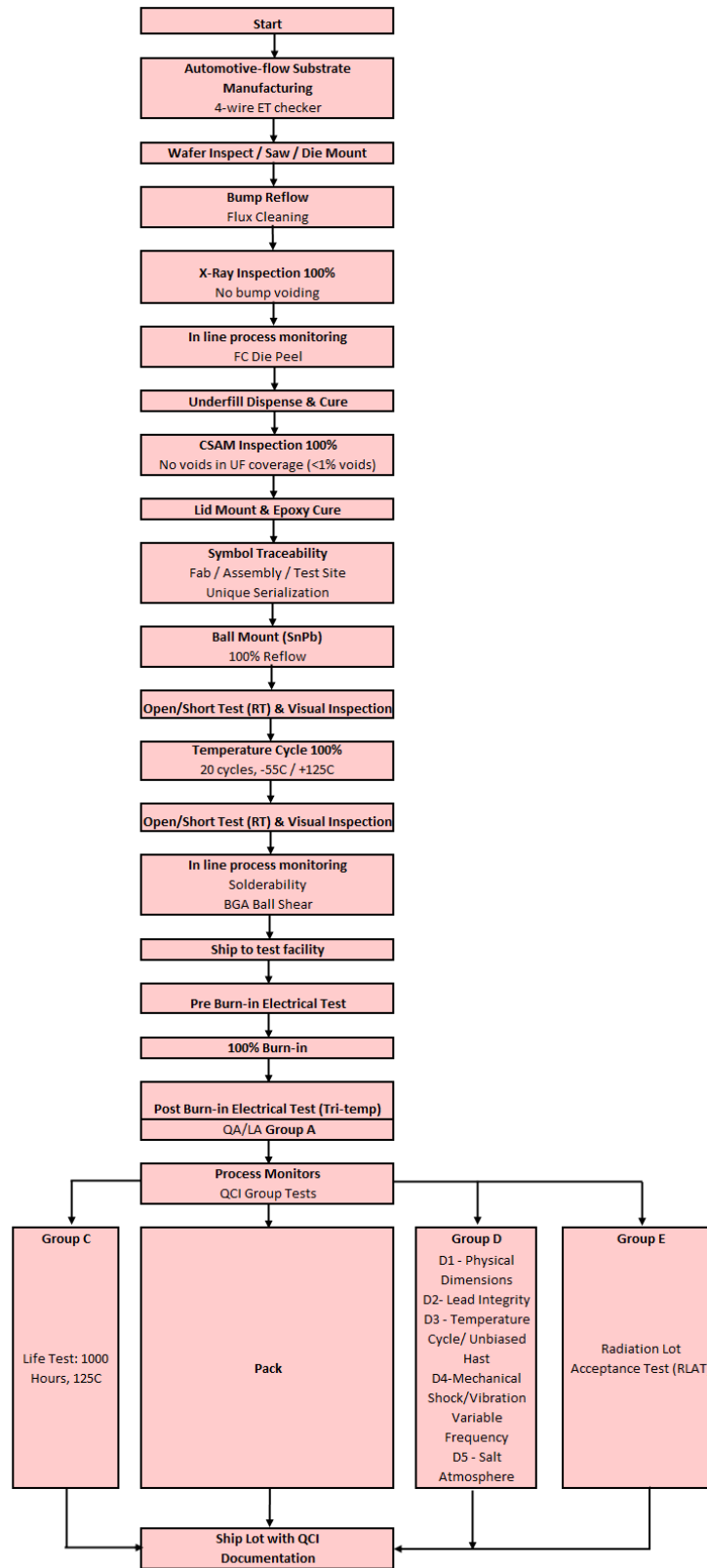


Figure 2-1. DAC39RF10-SP Screening Flow

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 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 is 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 is 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

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 Datasheet / 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

An 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 $5 \times 10E-5$ 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

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.

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (February 2026) to Revision A (March 2026)	Page
• Updated figure DAC39RF10-SP Screening Flow.....	2

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