

ADC12QJ1600-SHP Production Flow and Reliability Report



ABSTRACT

This report presents the reliability and qualification results for the ADC12QJ1600-SHP, a radiation-hardness-assured (RHA), 300krad, 12-bit, single-, dual- or quad-channel 1.6GSPS Analog-to-Digital Converter (ADC). The ADC12QJ1600-SHP is manufactured with a controlled baseline and has the following advantages compared to commercial-grade devices:

- An extended product life cycle
- Controlled baseline: one fab, assembly and test site
- Product traceability
- Lot-acceptance testing

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1 Texas Instruments Space High Grade in Plastic Product Qualification and Reliability Report

TI qualification testing is a risk mitigation process that is engineered to assure device longevity in customer applications. Wafer fabrication process and package level reliability are evaluated in a variety of ways that may 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 assure continuity of supply to customers. TI Space High Grade in Plastic (SHP) products are qualified with industry standard test methodologies performed to the intent of Joint Electron Devices Engineering Council (JEDEC) standards and procedures.

2 Space High Grade in Plastic Production Flow

2.1 Device Introduction

ADC12QJ1600-SHP is a radiation hardened by-design (RHBD) device in an organic flip-chip package that is suitable for use in space applications. The 10 × 10mm 144ALR package utilizes eutectic tin-lead (SnPb) die-bumps and external SnPb BGA balls. The device was verified as single event latch-up (SEL) immune to 120 MeV × cm²/ mg at a junction temperature of 125°C. The ADC12QJ1600-SHP is manufactured with TI's internal 65nm CMOS C021.A process.

Each fabrication lot is tested according to the MIL-STD-883 requirements for Radiation Lot Acceptance Testing (RLAT) up to 300 krad(Si) and each assembly and test lot follows the process flow shown in [Figure 2-1](#). To verify the quality of ADC12QJ1600-SHP, the device has been tested and qualified to meet space-grade requirements for LEO, MEO, GEO and deep-space missions beyond Earth's orbit. See [Section 3](#) for further details.

2.2 ADC12QJ1600-SHP Space High Grade in Plastic Production Flow

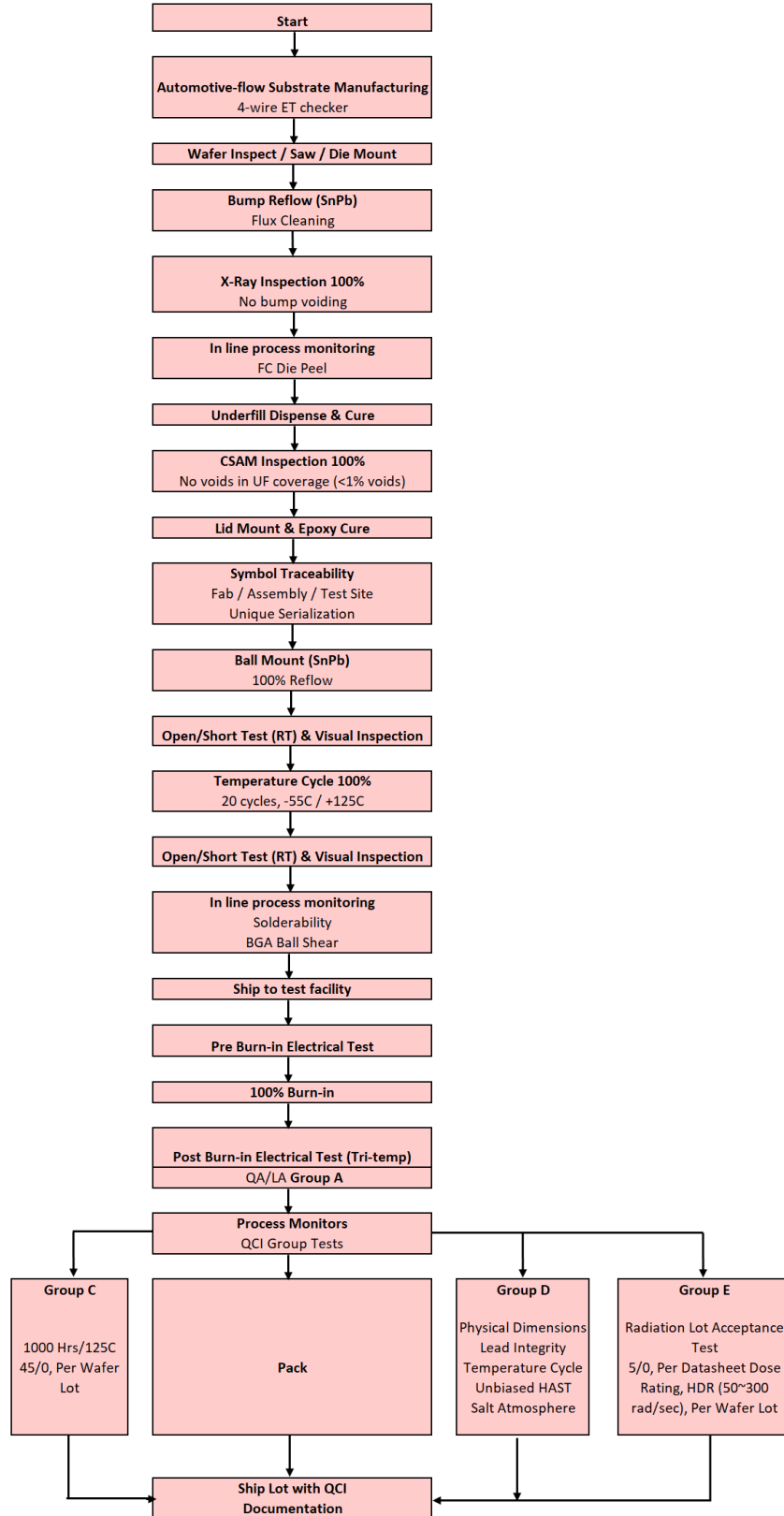


Figure 2-1. ADC12QJ1600-SHP Space High Grade in Plastic Production Flow Chart

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 will be 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 in order for the QBS rules to apply. The attributes which are expected and allowed to vary will be 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. ADC12QJ1600-SHP Qualification Matrix

Note that qualification by similarity ("qualification family") per JEDEC JESD47 is allowed.				
Description	Condition	Sample Size Used/ Rejects	Lots Required	Test Method
Electromigration	Maximum Recommended Operating Conditions	N/A	N/A	Per TI Design Rules
Electrical Characterization	TI Data Sheet	30	1	N/A
Electrostatic Discharge Sensitivity	HBM	3 units/voltage	1	ANSI/ESDA/JEDEC JS-001
	CDM			ANSI/ESDA/JEDEC JS-002
Latch-up	Per Technology	3/0	1	EIA/JESD78
Physical Dimensions	TI Data Sheet	5/0	1	EIA/JESD22- B100
Thermal Impedance	Theta-JC on board	Per Pin-Package	N/A	Modelling
Bias Life Test	125°C / 1000 hours or equivalent	45/0	1	JESD22-A108*
Temperature Humidity Bias	85°C / 85% / 1000 hours	77/0	1	JESD22-A110*
Extended THB	85°C / 85% / 2600 hours (for reference)	77/0	1	JESD22-A110*
Unbiased HAST	110°C / 85% / 528 hours	77/0	1	JESD22-A.118*
Temperature Cycle	-55°C to +150°C non-biased for 1000 cycles	77/0	1	JESD22-A104*
High Temperature Storage Life	150°C, 1000 hours	77/0	1	JESD22-A103*
Solderability	22 leads, min 3 devices, 245C +5C	22/0	1	J-STD-002
Flammability	Method A / Method B	5/0	1	UL 94V0, Method A
Radiation Response Characterization	Total Ionization Dose (TID)	2 units/dose level	1	MIL-STD-883/Method 1019
Radiation Response Characterization	Single Event Latch-up (SEL)	3	1	MIL-STD-883/Method 1019
RLAT	Radiation Lot Acceptance Testing	5/0		MIL-STD-883/Method 1019
Outgassing Characterization, packaged unit	TML (Total Mass Lost) <=1%, CVCM (Collected Volatile Condensable material) <=0.1%	5/0	1	ASTM E595
Salt Atmosphere	Salt atmosphere, visual inspection	15/0	1	TM1009

*Precondition performed per JEDEC Std. 22, Method A112/A113.

4 Outgas Test Report

Outgassing test was performed on five units. 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 5×10^{-5} torr according to ASTM E595, for a duration of 24 hours, at 125°C. The TML and CVCM were measured after the test.

Table 4-1. Outgas Test Results

SAMPLE	TML < 1.0%	CVCM < 0.1%
ADC12QJ1600ALRSHP	PASS	PASS

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