



CDS/ADC and DAC ASIC PACKAGING, Doc. No.: RAL-ASIC-SP-0001

QUALIFICATION AND TEST

Issue: 1.0

STATEMENT OF WORK

Date: 12-Dec-18

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CDS/ADC and DAC ASIC PACKAGING, QUALIFICATION AND TEST

STATEMENT OF WORK

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CHANGE LOG

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1 Introduction

This document constitutes the Statement of Work for the packaging and test of RAL Space's CDS/ADC and DAC ASICs. It outlines the requirements of the work to be performed and management thereof.

2 Abbreviations

AD	Applicable Documents
ADC	Analogue-to-Digital Converter
AMS	Austria Mikro Systeme - An Austrian ASIC manufacturer
ASIC	Application Specific Integrated Circuit
CCD	Charged Coupled Device
CDS	Correlated Double Sampling
CMOS	Complimentary Metal-Oxide Semiconductor
CQFP	Ceramic Quad Flat-Pack
DAC	Digital-to-Analogue Converter
DPA	Destructive Physical Analysis
LET	Linear Energy Transfer
NRE	Non-recurrent engineering
PA	Product Assurance
RAL	Rutherford Appleton Laboratory
SEL	Single-event latchup
SEM	Scanning Electron Microscopy
SOW	Statement of Work
STFC	Science and Technology Facilities Council
TBA	To be Advised
TBC	To be Confirmed
TBD	To be Decided
TID	Total Ionising Dose
TM	Test Method
UK	United Kingdom
UKSBS	UK Shared Business Services
WBS	Work Breakdown Structure

3 Applicable Documents

The following documents contain provisions, which though reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the applicable documents listed below. For undated references, the latest edition of the document referred to applies.

Table 1 Applicable Documents

	Document title	Document reference	Issue	Date
AD1	CDS/ADC ASIC MK10 Design Description Specifications and Data Sheet	RAL-ASIC-CDS10-SP-0001	1.1	18/10/18
AD2	CDS/ADC ASIC MK10 Test Requirements	RAL-ASIC-CDS10-RS-0001	1.0	18/06/18
AD3	DAC ASIC MK3 Specifications and Data Sheet	RAL-ASIC-DAC3-SP-0001	2.1	18/10/18
AD4	DAC ASIC Test Requirements	RAL-ASIC-DAC3-RS-0003	2.1	18/06/18

4 Background and Objectives

4.1 Background

4.1.1 CDS/ADC ASIC

RAL Space has developed a radiation-hardened Correlated Double Sampling/Analogue-to-Digital Converter (CDS/ADC) CCD video processing and digitisation ASIC. The ASIC consists of an integrated video preamplifier and CDS processor with programmable video offset, a programmable video gain amplifier and a 16-bit ADC (AD1). It is fabricated on the radiation-hard AMS C35 CMOS process. It can operate from a single 3.3 V power supply, and typically consumes ~125 mA. The key features are listed in AD1 section 4.1.

4.1.2 DAC ASIC

RAL Space has developed a radiation-hardened 8-channel, 10-bit Digital-to-Analogue (DAC) ASIC. The ASIC is an 8-channel programmable digital-to-analogue converter with 10-bit voltage-output DACs (AD3). It is fabricated on the radiation-hard AMS C35 CMOS process. It can operate from a single 3.3 V power supply, and typically consumes ~15 mA under zero-load conditions. The key features are listed in AD3 section 4.1.

4.2 Objective of the activity

The objectives of the activity are to package the CDS/ADC and DAC ASIC die, qualify, and perform electrical and radiation testing, to produce space-qualified ASIC chips.

5 Work to be performed

5.1 Work Logic

The work to be performed for both the CDS/ADC and DAC ASICs shall include the following Work Packages:

- Work Package 1: Package procurement and Non-Recurrent Engineering (NRE)
- Work Package 2: Prototype build and test
- Work Package 3: Packaging and test of CDS/ADC and DAC ASICs
- Work Package 4: Radiation testing for CDS/ADC and DAC ASICs

5.1.1 Work Package 1: Package procurement and Non-Recurrent Engineering (NRE)

Input: This SoW, AD1, AD2, AD3, AD4

Task descriptions. The contractor shall:

- Procure appropriate 84-pin ceramic packages for the ASIC die to be mounted within.
- Design and construct all test fixtures including electrical burn-in boards and electrical test hardware to validate the electrical specification, electrical operation, and to characterise the performance of the packaged ASICs.
- Develop the software needed to test and characterise the ASICs as per our requirement specifications.

5.1.2 Work Package 2: Prototype packaging, qualification and test

Input: This SoW, AD1, AD2, AD3, AD4

Task descriptions. The contractor shall:

- Package and test both CDS/ADC and DAC ASIC die in accordance with the Production process flow outlined in Section 5.2, Prototype Build. Up to six of each ASIC die shall be available for the prototype build, including setup/test units, with suggested use, for each ASIC, as follows:
 - 1 unit for die shear/bond pull
 - 2 units for setup and debugging
 - 3 units to be screened as per the **Prototype Build** flow in 5.2, of which one unit shall be sent for DPA and SEM
- All packaging and test data shall be retained and made available.

5.1.3 Work Package 3: Production packaging, qualification and test

Input: This SoW, AD1, AD2, AD3, AD4

Task descriptions. The contractor shall:

- Package and test both CDS/ADC and DAC ASIC die in accordance with the Production process flow outlined in SoW Section 5.2, **Production Build**.
- All packaging and test data shall be retained and made available.

5.1.4 Work Package 4: Radiation testing for CDS/ADC and DAC ASICs

Input: This SoW, AD1, AD3

Task descriptions. The contractor shall:

- Perform TID testing as described in SoW Section 5.3.1. Comprehensive test report to be provided.
- Perform SEL testing as described in SoW Section 5.3.2. Comprehensive test report to be provided.
- All test data shall be retained and made available.

5.2 Production process flow for ASIC packaging and test

<u>Packaging/ Screening test</u>	<u>Test Method (TM) (Mil-Std-883 if applicable)</u>	<u>Conditions (if applicable)</u>	<u>Comments</u>	<u>Prototype Build</u>	<u>Production Build</u>
Incoming die inspection	TM 2010	Condition A, where applicable		✓	✓
Die attach			As per section 5.4.1	✓	✓
Die shear	TM 2019		1 pc	✓	✓
Destructive bond pull test	TM 2011	Condition D – double bond	22 wires 1 device	✓	✓

<u>Packaging/ Screening test</u>	<u>Test Method (TM) (Mil-Std-883 if applicable)</u>	<u>Conditions (if applicable)</u>	<u>Comments</u>	<u>Prototype Build</u>	<u>Production Build</u>
Internal Visual Inspection	TM 2010	Condition A		✓	✓
Stabilisation bake	TM 1008	100%		✓	✓
Serialisation		100%	As per 5.4.2	✓	✓
Resistance to solvents	TM 2015	3 devices		✓	✓
Temperature cycling	TM 1010	Condition C	10 cycles	✓	✓
Constant acceleration	TM 2001	Condition E	Y1 orientation only	✓	✓
Seal test a) Fine leak b) Gross leak	TM 1014		No retests accepted	✓	✓
Particle Impact Noise Detection (PIND)	TM 2020	Condition A on each device			✓
Radiographic (X-ray)	X-ray: TM 2012, two views				✓
Trim				✓	✓
Pre burn-in (interim) electrical parameters test		As described in section 5.5			✓
Burn-in test	TM 1015	Condition B, see note ii.	240 hours at 125°C		✓
Post burn-in (interim) electrical test		As described in section 5.5	This may be combined with the ambient final electrical tests below.		✓
Final electrical tests		100%	As described in section 5.5	Just ambient	✓
Radiographic (X-ray)	X-ray: TM 2012, two views				✓
External visual inspection	TM 2009			✓	✓
Delid SEM and DPA (one of each ASIC)				✓	

Notes:

- i. Reverse bias burn-in is not required
- ii. Burn-in circuits as specified in AD2 and AD4

Additional:

- Failure analysis (TM 5003) is not required

5.3 Radiation testing

5.3.1 Total Ionising Dose (TID) testing

Testing shall be performed as per ESCC 22900.

TID
Ambient electrical test
Irradiate at 20 Krad
Ambient Electrical test
Irradiate at 35 Krad
Ambient electrical test
Irradiate at 60 Krad
Ambient electrical test
Test report

5.3.2 Single Event Latch-up (SEL) testing

Testing shall be performed as per ESCC 25100.

SEL- threshold $\leq 120 \text{ MeV cm}^2/\text{mg}$
At 25°C
Up to 100 events or $1\text{E}7 \text{ ions/cm}^2$
Test with 3 LET values: Xe (without and with tilt), ~ 60, 100, 120 $\text{MeV cm}^2/\text{mg}$
If part is sensitive at Xe without tilt, test performed at Kr
Test report

5.4 Package specification

5.4.1 Package

The package shall have a die cavity to fit the die dimensions of each chip and be packaged as per the bonding diagrams, defined in AD1 and AD3, with the following requirements;

- 84-pin CQPF
- 0.025 inch lead/pin pitch
- Lid grounded via pin 1 (optional, but highly desirable)

5.4.2 Serialisation

Packages shall be labelled with the following information;

- Name of chip and version (“CDS/ADC 10” or “DAC 3”)
- Date code
- Serial number

To ensure sufficient readability, the height of the lettering used shall be no less than 3mm. Either ink jet or laser may be used for marking the parts.

5.5 Electrical tests

5.5.1 Burn-in

As a minimum, the complete set of electrical tests as defined by AD2 and AD4 shall be performed both before and after burn-in. All results shall be recorded and provided to RAL along with a comprehensive written report.

5.5.2 Final electrical tests

As a minimum, the complete set of electrical tests as defined by AD2 and AD4 shall be performed at ambient, hot and cold cases. The required temperatures are defined in AD2 and AD4. All results shall be recorded and provided to RAL along with a comprehensive written report.

6 Requirements for management, reporting, meetings and deliverables

6.1 Management

The Contractor shall establish a Project Management Plan, setting out all methodologies, processes, and procedures which the contractor is to use when managing the project. The Contractor shall adhere to the Project Management Plan and keep it up to date.

6.2 Reporting

Reporting shall be by a monthly report document from the contractor, sent by e-mail, to the RAL Project Manager.

6.3 Meetings

There shall be provision for fortnightly telecons between the contractor and RAL Space throughout the duration of the work. In addition there will be milestone meetings as detailed in 7.2.

6.4 Facility Audit

RAL shall reserve the right to perform a facility audit.

6.5 Deliverables

Target yield of:

- 188 CDS ADC ASICs from 208 die available for production run.
- 75 DAC ASICs from 86 die available for production run.

Data pack (electronic) containing:

- Test data
- Test reports

All packaged die (whether passed or failed) shall be returned to RAL.

6.6 Warranty

A minimum of 12 months warranty shall apply to all parts from WP3 that have successfully passed packaging, screening and electrical test verification.

7 Schedule and Milestones

7.1 Duration

The duration of the work shall not exceed T0 + 12 months to Qualification Review and T0 + 18 months to Radiation Testing and Final Delivery Review (see below).

7.2 Milestones and reviews

The following reviews shall be held:

- a) Kick-off meeting, at the start of the activity
- b) Design Review
- c) Sample Test Review
- d) Packaging Review
- e) Qualification Review
- f) Radiation Testing and Final Delivery Review

Meeting	Schedule	Location
Kick-off	T0 = Start of activity	STFC RAL
Design Review	T0 + TBA	STFC RAL
Sample Test Review	T0 + TBA	STFC RAL
Packaging Review	T0 + TBA	Telecon
Qualification Review	T0 + 12 months	STFC RAL
Radiation Testing and Final Delivery Review	T0 + 18 months	STFC RAL

TBA = To be advised by contractor