

Electrically Coupled Angular Decoder for Long-Life Mechanisms

Final Review

ESA Contract:
4000124988/18/NL/BJ/gp
February 21th, 2020

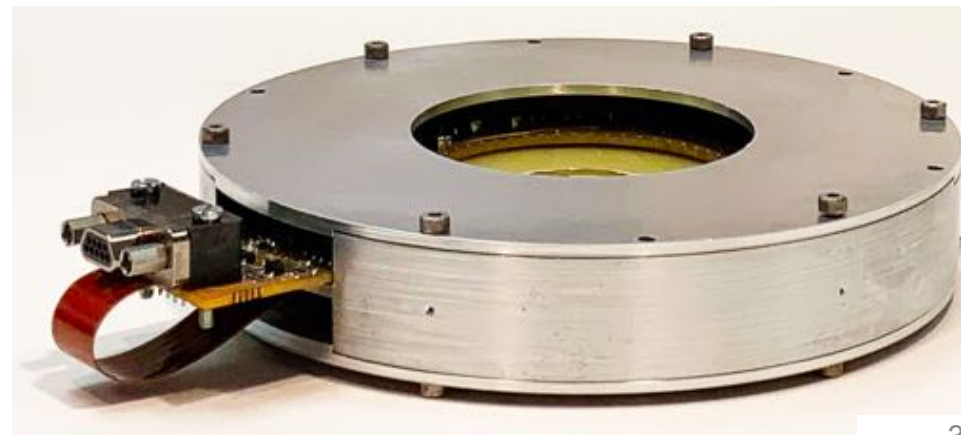
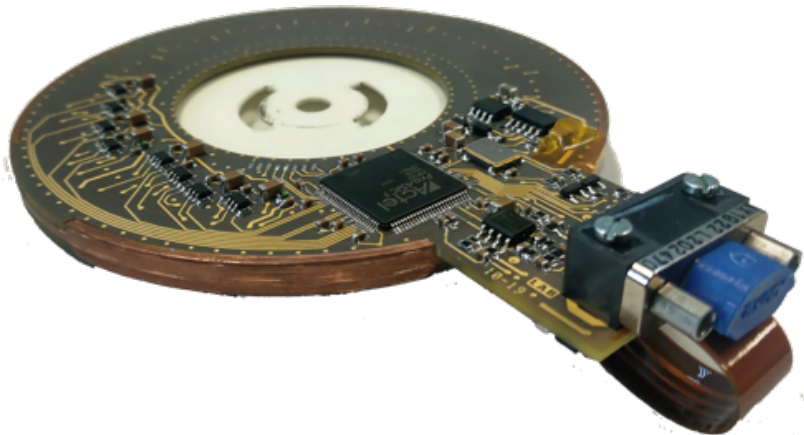
1. Welcome and presentation of participants.
2. Review of the project and presentation of the tests results: project conclusions.
3. Discussion of RIDs.
4. Review of closure documents.
5. Review of follow up actions and roadmap
6. AoB.

OBJECTIVE

Results from ESA Contract No. 4000124988/18/NL/BJ/gp “Electrically Coupled Angular Encoder for Long-Life Mechanisms” and ARTES 5.2 contract 4000104613/12/NL/AD “Electrically Coupled Angular Encoder for Long-Life Mechanisms”, whose **objectives are to provide the space industry with a medium resolution (16-bits) ECSS compliant angular sensor.**

Main contributions of this project are:

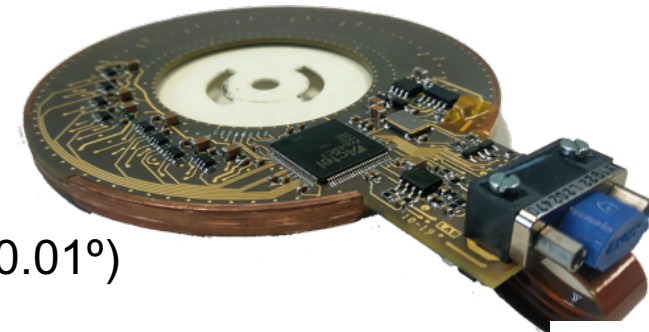
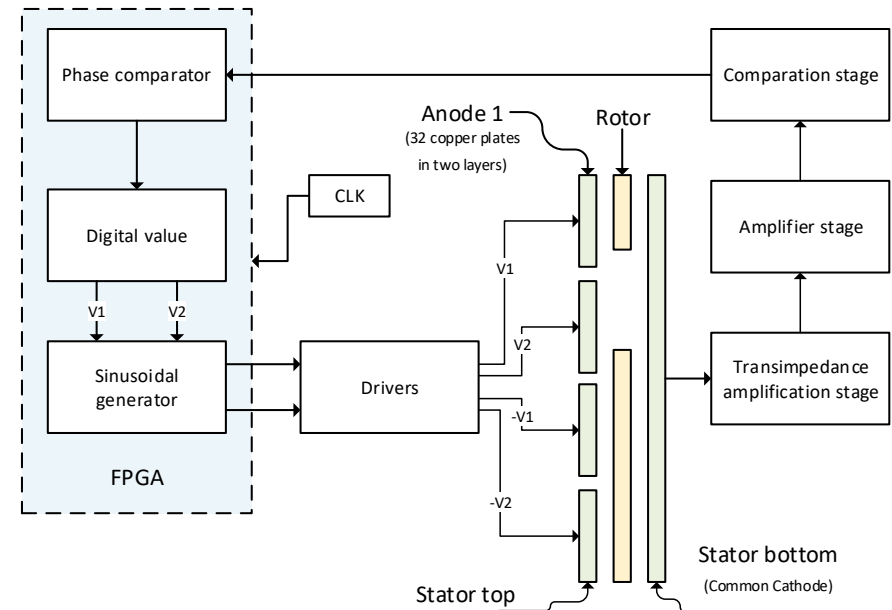
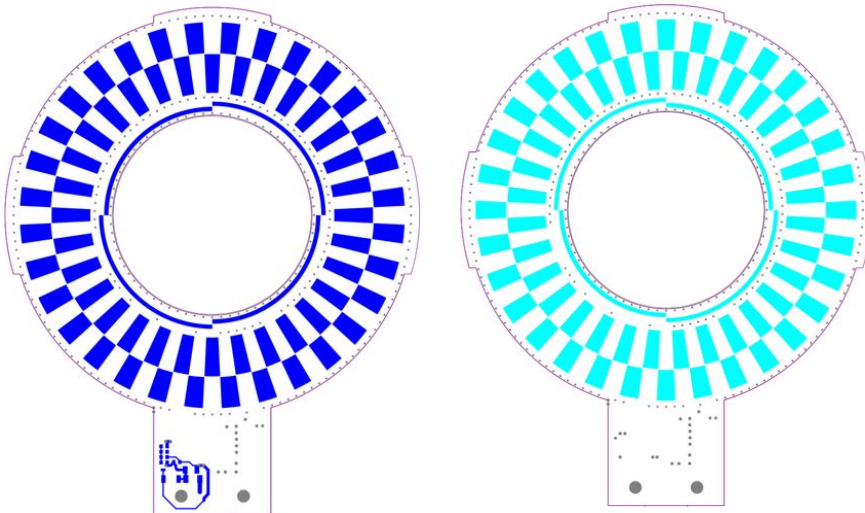
- Redesign with hardware differences are listed in TN30 Annex 5
- Firmware modification with differences are listed in TN50 § 6
- Test plan & test results to evidence required functioning of the sensor



2. Review of the project

Summary of results (i):

- Simple electronics due to use of current nulling technique: sinusoidal voltages within the sensor do not produce synchro/resolver processing.
- Patent pending electrical coupling structure



Ø 9cm - 16-bits (0.01°)
12 mm profile

2. Review of the project

Delivered documents for RR:

TN10: Mechanical, Interface and Electrical specification.

Analysis of requirements in applicable documentation.
Update and Consolidation of Specification
Update of design description.

TN20: Test Equipment Specification and Verification Plan.

Establish a Design and Development approach in line with schedule constraints.

Delivered documents for DR:

TN30: CLAS Detailed Design

Detailed design of contactless sensor

DP1: CLAS sensor design pack

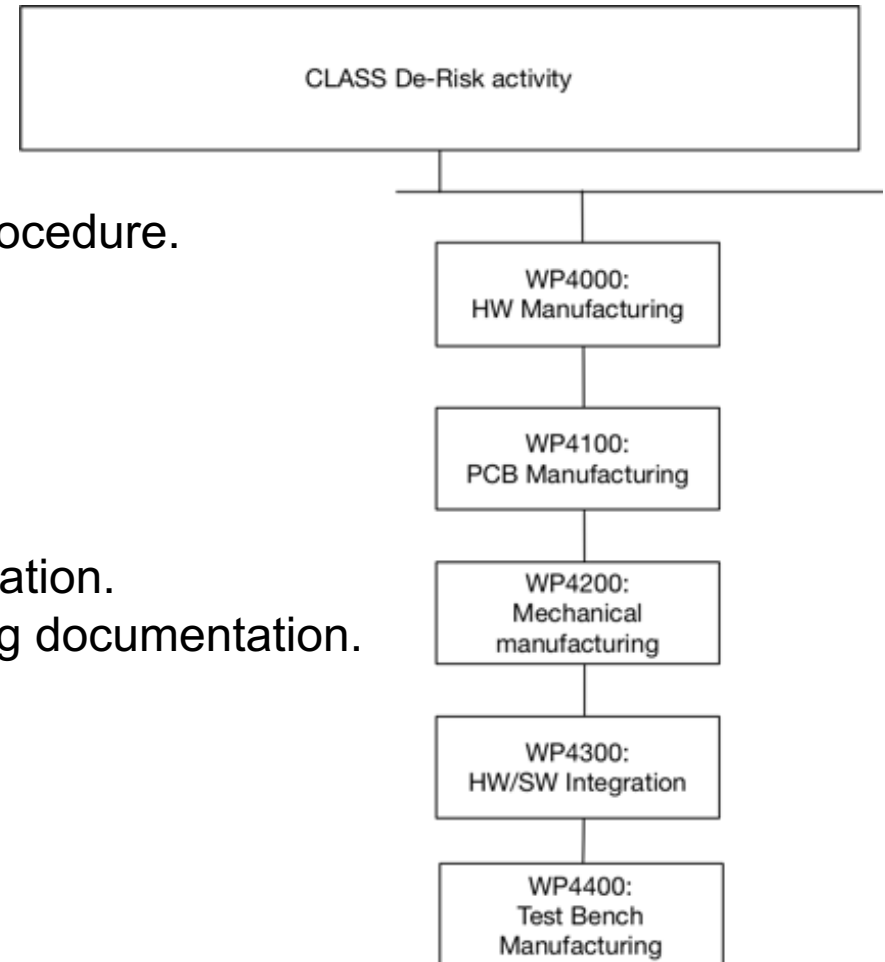
Sensor schematics and GERBERs for sensor
3D mechanical CADs for sensor
Mechanical manufacturing files for sensor

DP2: Test bench design pack

Sensor schematics and GERBERs for test bench
3D mechanical CADs for test bench Mechanical manufacturing files for test bench

Delivered documents for TRR

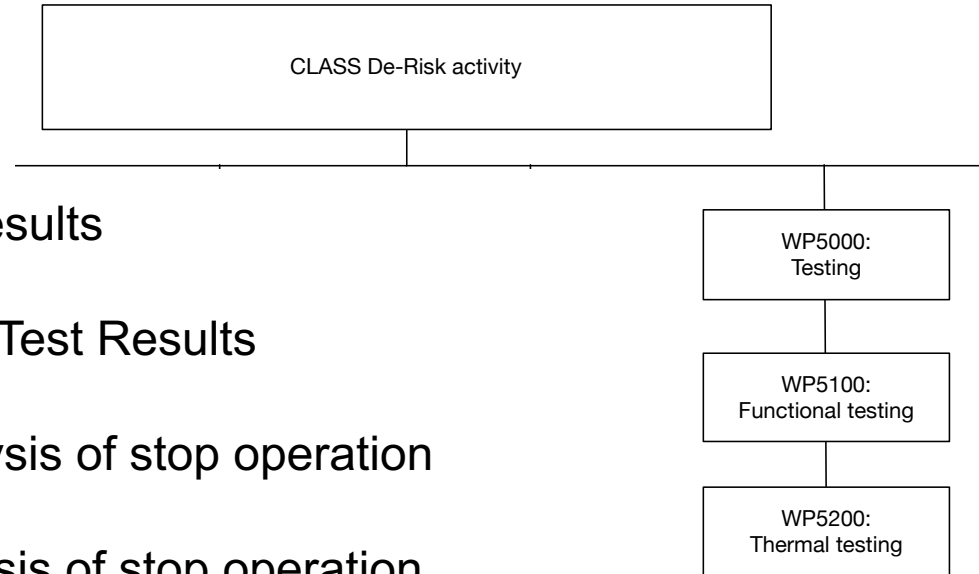
- TN40:** User's Manual and Handling Procedure.
- TN45:** Declared Materials List
- TN46:** Declared Procedures List
- TN50:** Firmware description for CLAS
/ FW-0001 Firmware for CLAS.
- TN60:** Test Bench User Manual.
- TN70:** CLAS manufacturing documentation.
- TN75:** CLAS Test-bench manufacturing documentation.
- TN80:** Test plan



2. Review of work

Delivered documents for FR

- EMX-CLA3-TN-0090-ISS01 Test Results
- EMX-CLA3-TN-0091-ISS02 Partial Test Results
- EMX-CLA3-TN-0092-ISS01 – Analysis of stop operation
- EMX-CLA3-TN-0093-ISS01 - Analysis of stop operation



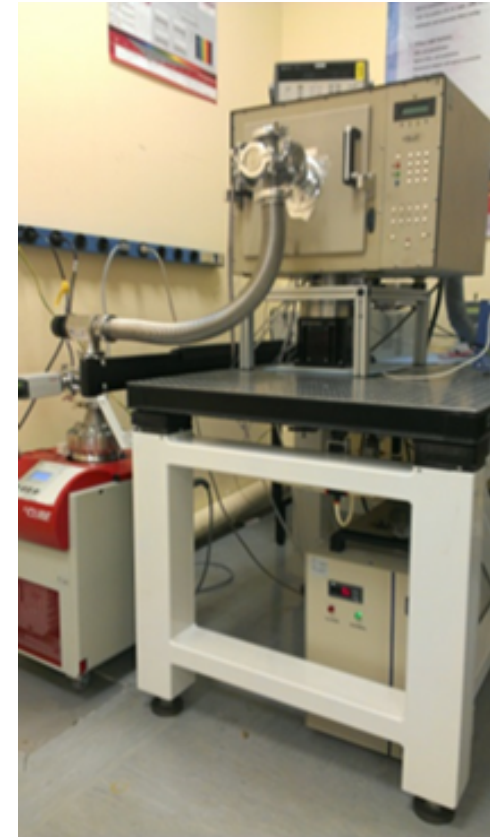
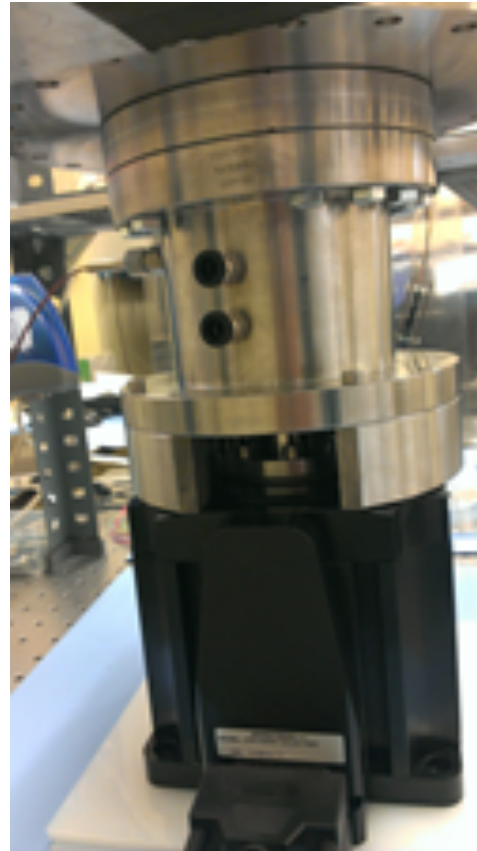
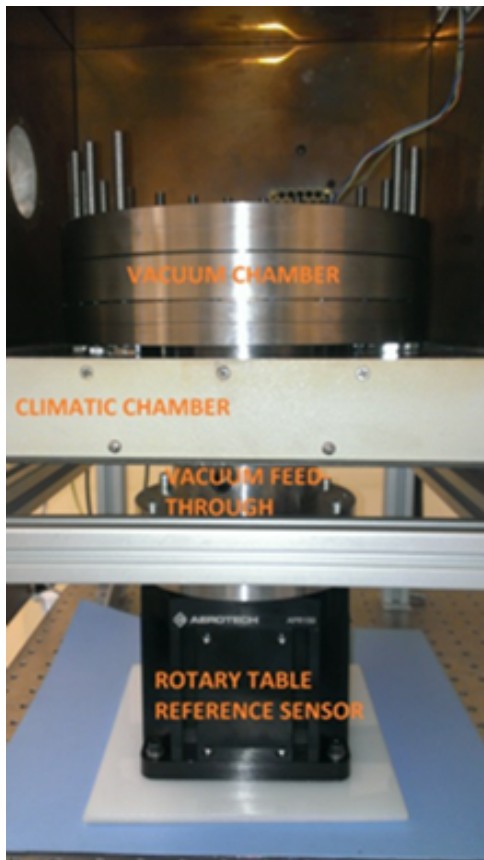
RIDs documents to review

EMX-CLA3-RID-0001-ISS04_RRMeeting
EMX-CLA3-RID-0002-ISS04 DR
EMX-CLA3-RID-0003-ISS02 TRR
EMX-CLA3-RID-0004-ISS01 FR

2. Review of work

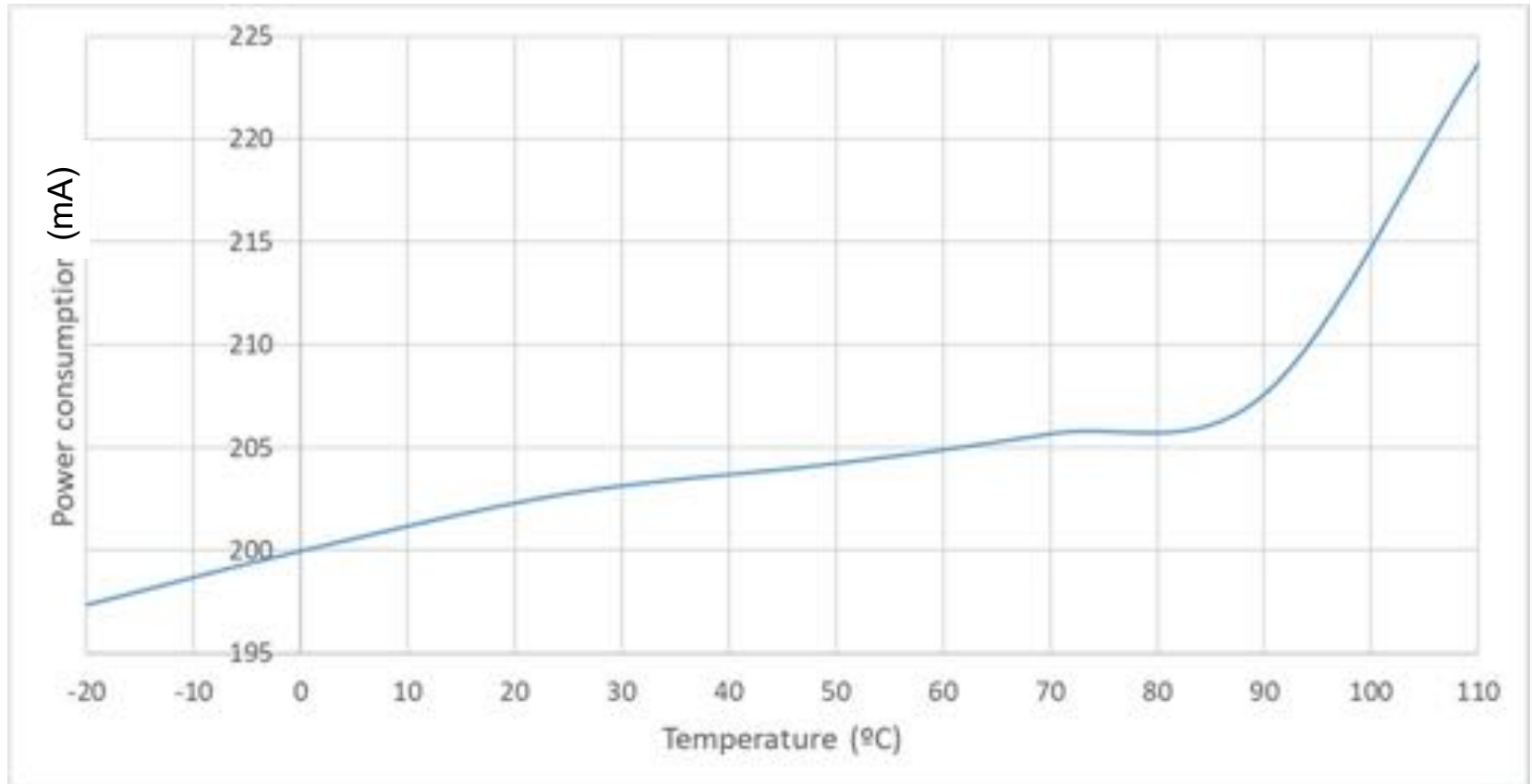
- Absolute angle encoding with no mechanical contact.
- Adaptable to any outer and inner shaft diameter: \varnothing 10cm (with enclosure) - **16-bits (0.01°)**.
- Low profile: 20mm with enclosure.
- Flexible digital interface in parallel or serial form.
- Serial communication RS-485/RS-422. Available CAN or LVDS interfaces upon request.
- Analog (2-wire) interface realizable in the same electronic design.
- Single supply and very low power **consumption <2W** (+5.0V).
- Extended temperature range **(-55C to +90C)**, and operational in radiation environments.
- Qualified electronics and materials for Space, military or aeronautical applications.
- FPGA based conditioning electronics. All electronics included in the enclosure.

Test bench development for angular sensors environmental characterization



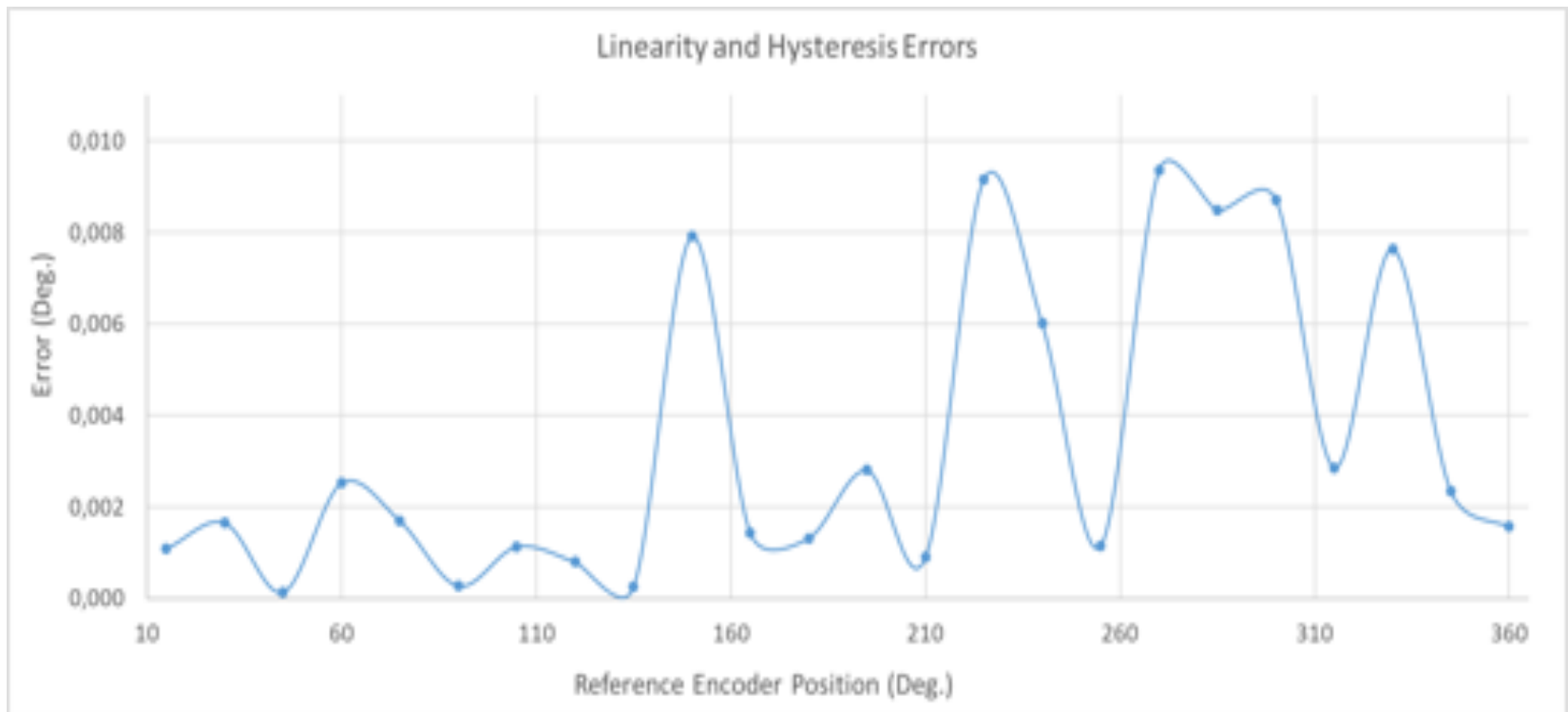
2. Review of the project

Test result - Consumption



2. Review of the project

Test result - Linearity and hysteresis errors (23° C)



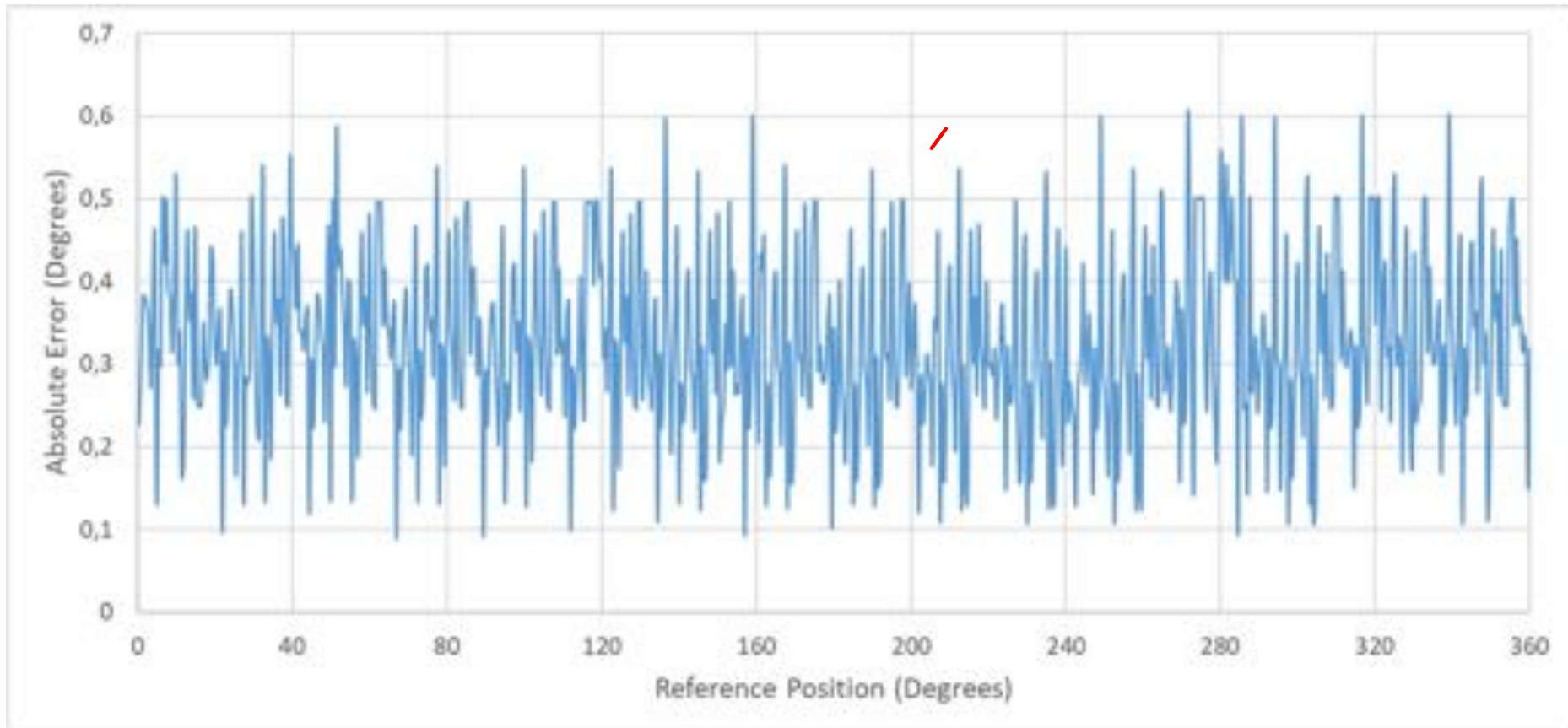
2. Review of the project

Test result - Repeatability (23°C)



2. Review of the project

Test result – Temperature measurement error



2. Review of the project

Test result – NC analysis

CLAS3_030	Measurement accuracy is $\pm 0.01^\circ$	Partially C	See §3.7 and §3.8
CLAS3_040	Maximum supported speed 25°/second	TBD	To be verified.
CLAS3_060	Temperature stability < 50ppm/°C	NC	Results are not definitive due to testbench mechanical issues
CLAS3_300	Qualification temperature -55°C to +110°C	NC	Not verified within this project but verified in [RD2]
CLAS3_310	Acceptance temperature should be within a range -55°C to +70°C in compliance to ECSS-Q-ST-30-11C Rev 1.	NC	Not verified within this project but verified in [RD2]

Review of RIDs to delivered documentation.

RIDs in previous EXCEL archives:

- EMX-CLA3-RID-0001-ISS03_RRMeeting (CLOSED)
- EMX-CLA3-RID-0002-ISS03_DR (CLOSED)
- EMX-CLA3-RID-0003-ISS02_TRR (Actions closed, to be reviewed)

RIDs for FR:

- EMX-CLA3-RID-0004-ISS01_FR

Closure configuration control is listed in

- See document EMX-CLA3-CCD-ISS01 Contract Closure Documentation

Roadmap:

- Develop three angular sensors for terrestrial aeronautical, defense and terrestrial applications. (timeframe 2020)
 - Ø 6cm - 12-bits (0.1°).
 - Ø 9cm - 16-bits (0.01°).
 - Ø 15cm - 19-bits (0.001°).
- Reach TRL9 with a flight opportunity and follow the line of three sensors described above.

Actions:

- ESA Open Space Innovation Platform - OSIP (10k CCN for market and applicability study) - Submitted
- ESA ESA AO/1-10147/20/NL/MH Invitation to Tender for Announcement of Opportunity for Technology Transfer Proof of Concepts (28/2 deadline) – 6 months study
- GVA project (timeframe)

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 - Sensor modifications for cost competitive solution
 - Prototype implementation
 - Test
- GVA project (12 months starting 01/04)
 - Sensor product line implementation
 - Promotion & market activities

- **Contactless angular sensor ECSS compliant; FMECA, PSA, WCA available; No catastrophic failures guaranteed.**
- **Error within 0.01° (16 bits) for -55°C to +90°C after calibration**
- **+5V supply, 2.25W worst case consumption, RS485 interface**
- **All electronics within the enclosure**
- **Our aim is to set a market product in early 2021.**