CTA+
LARGE SIZED TELESCOPE SOUTH

LSTS-SOW-INAF-0003-01

CAPITOLATO TECNICO MIRROR FACET ACTUATORS (STATEMENT OF WORK)

Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

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1 INTRODUCTION

1.1 SCOPE OF THE DOCUMENT

This Technical Specification aims to provide a detailed description of the activities, timeline, documentation, and organization required by INAF, the contracting authority, to achieve the objectives of the tender. The Specifications will govern the execution of the contract and will serve as a document applicable throughout the entire performance of the assignment.

1.2 BACKGROUND

The *Cherenkov Telescope Array Observatory* (CTAO, https://www.cta-observatory.org) is an international project structure distributed across four main sites: *Headquarters* (Bologna, Italy), *Science Data Management Center* (Zeuthen, Germany) and the two array sites in the northern hemisphere (Observatorio del Roque de los Muchachos (ORM), La Palma, Spain) and southern hemisphere (between the ESO observatories of Cerro Paranal and Cerro Armazones in Chile).

The Observatory will consist on dozens of telescopes for the observation of Gamma Rays, divided into three configurations, in order to cover the energy range from about ten GeV (Large Sized Telescope, LST), to about ten TeV (Medium Sized Telescope, MST) and up to 100 TeV (Small Sized Telescope, SST) and properly distributed in the two sites.

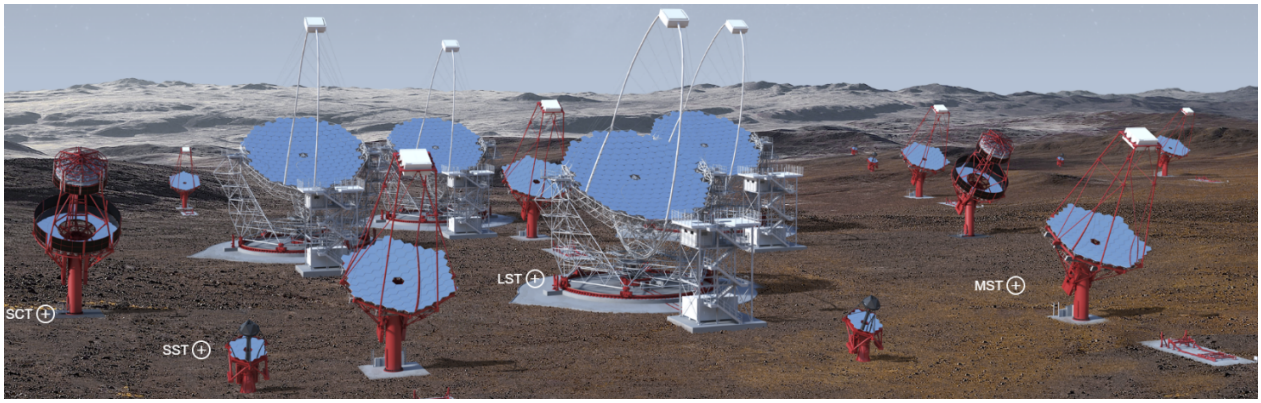

Figure 1.1 Cherenkov Telescope Array artist's impression

In this context, INAF is responsible for the **LST-South project** *(Large Sized Telescopes in the Southern Hemisphere)*: the design and manufacturing (for at least 2 telescopes) of the mount, mirrors and auxiliary systems and the integration and site testing (at least 1 telescope) of the entire telescope.

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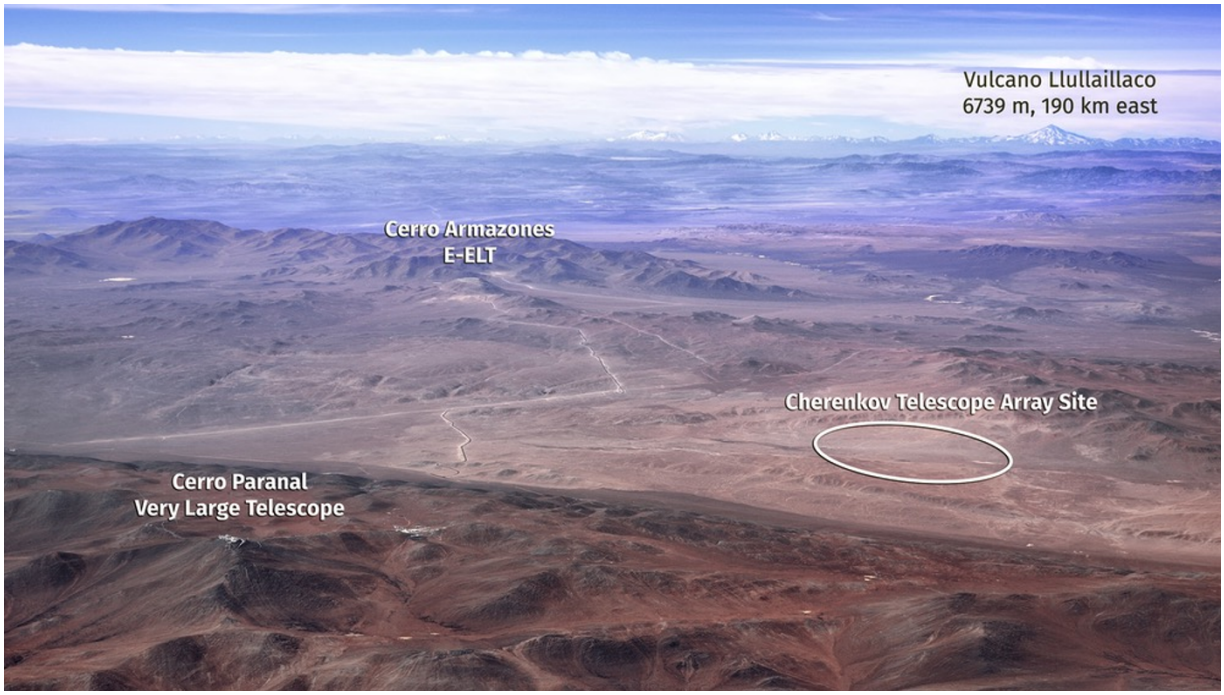

Figure 1.2 CTA South (Chile) location aerial view

LST is an alt-azimuth telescope with a 23 m primary diameter and 28 m focal length. The large aperture, combined with the high efficiency of photonic detection, allows you to detect atmospheric showers generated by low-energy gamma rays. These types of telescopes are placed in the center of the entire array to lower the detectable energy threshold and improve the CTAO sensitivity between 20 and 200 GeV.

Figure 1.3 Artist's impression of Large Sized Telescope into Cherenkov Telescope Array

1.3 THE PNRR NATIONAL PLAN

The National Recovery and Resilience Plan ("Piano Nazionale di Ripresa e Resilienza", PNRR) is part of the Next Generation EU (NGEU) program that the European Union negotiated in response to the pandemic crisis. The total amount of funds envisaged by Italy amounts to several hundreds of billions of euros implemented on specific axes and strategic missions. It is an intervention that aims at repairing the economic and social damage caused by the pandemic crisis, contributing to addressing the structural weaknesses of the Italian economy, and leading the country along a path of ecological and environmental transition and technological advancement.

CTA+ is a program approved by the Italian Ministry to be funded within the PNRR plan. This tender's objective delivers one important task of the project: the telescope mount for the LSTs in the South (CTA+ WP1220).

To reach the program goal, this tender enforces a specific timeline for the execution of the project whose schedule is one of the most demanding achievements since its end is fixed for June 2025. Moreover, a strict monitoring of the activities, costs and deliverables will be executed during the whole project by a supervisory body to ensure that the development of the project, in terms of time and costs, is in line with the proposal approved by the Ministry.

1.3.1 Disclaimer

LST-South is funded by European Union – "NextGenerationEU". The points of view and the opinions are only those of the authors of this document and do not necessarily reflect those of European

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Union or European Commission. Neither European Union nor European Commission can be held liable for those.

1.4 RELATED DOCUMENTS

1.4.1 Applicable documents

AD	Document code	Description
AD01	LSTS-SPE-INAF-0005	Actuator manufacturing and test specifications
AD02	LST-MDL-INAF-0005	Actuator model
AD03	LST-BOM-INAF-721000000	Actuator BOM
AD04	Oriental_motor_C062Q-9012K S-7003037	Stepper motor with cabling

1.4.2 Reference documents

RD	Document code	Description
RD01		

1.5 MAIN ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Full description
ACADA	Array Control And Data Acquisition system (CTA OES)
AIT	Assembly Integration Test
AMC	Active Mirror Control
BOM	Bill Of Material
CFRP	Carbon Fibres Reinforced Plastic
CI	Configuration Item
CTA	Cherenkov Telescope Array
CTAO	Cherenkov Telescope Array Observatory
HW	HardWare
INAF	Istituto Nazionale di AstroFisica
IPS	Integrated Protection System
LRU	Line Replaceable Unit
LST	Large Sized Telescope
LST-S	Large Sized Telescope South
NDA	Non-Disclosure Agreement
OD	Outer Diameter
OES	Observation Execution System, namely ACADA (see ACADA)
OPC-UA	Open Platform Communications, (formerly Object Linking and Embedding for Process Control) - Unified Architecture
PA	Product Assurance
PBS	Product Breakdown Structure

Acronym/Abbreviation	Full description
PCB	Printed Circuit Board
PI	Principal Investigator
PM	Project Manager
QTY	Quantity
SE	System Engineer
SW	SoftWare
TCS	Telescope Control System

2 SCOPE OF SUPPLY

This tender aims to procure actuators for aligning the tessellated mirrors of the two LST-South telescopes of the CTAO Observatory, for which INAF is responsible for implementation. These telescopes will be placed in the southern site of the CTAO observatory, located in Paranal, Chile. The telescopes will have tessellated mirrors, with each primary mirror consisting of 198 panels (or segments) that can be oriented using the actuators to achieve a parabolic surface as required by CTAO. We require 1100 actuators in total, which is equal to 550 sets of actuators (396 sets of actuators mounted on the two telescopes plus 154 spare sets. Each set consists of two actuators for moving a single reflecting panel.

The activities include a short period for engineering the limited number of actuators based on drawings provided by INAF.

Moreover, the supply will include the following activities:

- Performed preliminary tests on engineered and constructed breadboard systems.
- Fabrication of the mechanical components of the actuators based on the design provided by INAF.
- Fabrication of the electronic components of the actuators based on a design that INAF will provide.
- Production, acquisition, and assembly of all electromechanical and electronic components for the production of "end-to-end" actuators based on the design provided by INAF;
- Verification of the functionality of the actuators to guarantee the optical performance of the actuator acceptance process.
- Testing and qualification of the integration process.
- QA and PA activities and Testing and qualification of the actuators according to the acceptance process.
- Environmental and resistance tests of the actuators.
- Compatibility test with the interfaces provided by INAF.
- Production of the 550 sets of actuators (in total 1500 actuators).
- Packaging and shipping, with responsibility borne by the successful tenderer, to the company responsible for manufacturing the LST-South telescopes, according to the INAF on-going tender:
  https://inaf.ubuy.cineca.it/PortaleAppalti/it/homepage.wp?actionPath=/ExtStr2/do/FrontEnd/Bandi/view.action&currentFrame=7&codice=G00913&_csrf=PJYWF5L2WT3Z3DJROKLQN8I0ZF28KZPR
- Maintenance services under warranty for the replacement of components, or the entire good, found to be defective during the commercial warranty period and possibly during the extension period guaranteed by the economic operator at the time of the offer.

2.1 ACTUATOR LAYOUT AND COMPONENTS

A 2D section of one actuator, representative of the series of actuators to be produced, is given in the following Fig. 2.1, including a description of the different components.

The actuator consists of a stepper motor, coupled to a spindle. The spindle has a rolled M8x1 thread and drives a bronze nut. The nut is fixed with the piston. Torsion of the piston is eliminated by a guide pin mounted on the outer housing, which extends into the groove on the piston. The rotation of the spindle is transmitted to the transversal movement of the piston. The working stroke of the actuator is 34 mm, the positioning accuracy is ±5 µm. The approximate position of the piston is determined by a magnet and four Hall sensors mounted on a circuit board and arranged parallel to the piston stroke.

Higher positioning accuracy is achieved by incorporating information from the magnetic angular encoder mounted on the actuator PCB, which monitors the rotation of the motor shaft. A metal spherical joint is used between the piston and the flange that interfaces with the mirror pad. The actuator is self-locking, which reduces idle power consumption. The housing is IP68 rated. A soft PVC bellow seals the stroke. FKM O-rings are used at the interfaces between the various body components. Power and communication are provided by a 1 m long cable feed through the end cap. A connector is fitted to the other end of the cable. Each actuator is uniquely identified by an electronic serial number. The temperature and humidity inside the housing are continuously monitored, together with operating parameters such as encoder position, power consumption, peak and average currents.

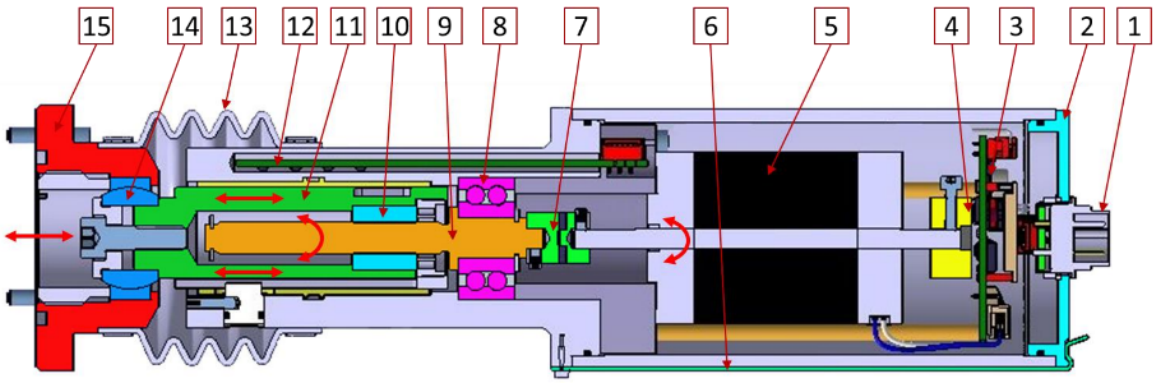

Figure 2.1 Actuator cross section

1. Power connector 24VDC, IP68 (with connected plug)
2. Aluminium cover (can be removed to access electronics)
3. Actuator Electronics board (Actuator PCB)
4. Angle transmitter for absolute positioning
5. Stepper motor

6. Spring clip
7. Clutch
8. Ball bearing.
9. Spindle
10. Nut connected to stamp
11. Stamp
12. Hall sensors for absolute positioning (Hall sensor PCB)
13. Bellow for sealing
14. Ball joint
15. Flange

The characteristics of the actuator design are listed here below:

- Mechanical
  - Stroke: 34mm (±17mm)
  - Resolution: ≤ 5 μm
  - Axial play: ≤ 20 μm
  - Operative axial load: till 700 N
  - Survival axial load: 9000N
  - Speed: 0.5 mm/s con applicato il carico operativo
  - Maximum angle at the ball joint: 15°
  - System is irreversible (locked when motor is inactive).
- Electrical
  - Maximum voltage 26 VDC
  - Operative current: ≤ 850mA
  - Standby current: ≤ 50mA
  - Absolute encoder
  - Protection: IP 68
- Data
  - Cabled version
  - RS485 serial communication
- Duty cycle
  - 3.6 millions of motion commands
- Temperature ranges
  - Storage/Shipment -20 / 70°C
  - Operative -5 / 25°C
  - Survival -15 / 35°C

The 3D model can be retrieved from AD02.

2.2 DOCUMENTATION RELATED TO SUPPLY

The Contractor must provide INAF with a set of documents for the project, as well as related documents for the parts produced, integrated, and tested for acceptance, according to the following scheme:

- Actuators production plan: plan describing how the Contractor intends to manage the work as well as a description of its development through:
  - Procurement plan.
  - Assembly plan and procedure.
  - Test and inspection plan and procedures.
  - Schedule.
- Risk Management e Risk Register
- Product Assurance plan e Configuration Control plan.
- Test report.
- Quality books.

All the documents shall be produced in English and must follow the requirements listed in Section 4.

2.3 ACTUATOR COMPONENT PROCUREMENT

2.3.1 Custom components

The list of components that need to be constructed is included in Section 6. Each component is identified as "Part" in the "Component type" column, and as "Normal" in the "BOM structure" column. The drawings for these components can be found in the "Reference Filename" column, and the corresponding files are located inside AD03.

The quantity of the parts (“QTY” column) refers to the number of components needed for a single assembly; for example, the assembly labelled 2.2.1.1.1 is present in a quantity of 3 units, each one including one (1) item 2.2.1.1.1.1 and one (1) item 2.2.1.1.1.2.

Item	Component Type	Part Number	BOM Structure	QTY
2.2.1.1.1	Assembly	M003	Normal	3
2.2.1.1.1.1	Part	M0002	Normal	1
2.2.1.1.1.2	Part	Bossard 1178857	Purchased	1

This means that to obtain a single actuator, both items 2.2.1.1.1.1 and 2.2.1.1.1.2 must be available in a quantity of three (3).

2.3.2 Off-the-Shelf components

The list of components to be purchased is provided in Section 6, specifically for the ones marked as "Part" in the "Component type" column and "Purchased" in the "BOM structure" column. Their quantities are stated as described in the previous paragraph.

Please find the following information regarding the electronics section of the project:

- Section 6 and the "Electronics" folder inside AD01 contain the part lists for electronics.

- The contractor will only receive access to the complete set drawings related to the electronics after signing a Non-Disclosure Agreement (NDA) document. Upgrades of components included in this contract. The design drawings will be provided during the Kick-Off Meeting.

Concerning the part list in section 6, all the following items need to be changed as per what is reported below:

- The item 1.6 shall be procured in FKM (Viton) material.
- Item 2.2.1.1.4.4 shall be changed with off-the-shelf Huco coupling 232.13.
- Item 2.2.2.1.3 shall be procured in FKM (Viton) material.
- Item 2.2.2.2.2.4 shall be changed with off-the-shelf Huco coupling 232.13.
- Item 2.2.2.3 shall be changed with off-the-shelf Huco coupling 236.13.
- The item 2.2.2.4 shall be procured in FKM (Viton) material.
- Assembly 2.3 will have minor design changes to apply a 4 pin connector. Those changes will be provided at Kick-Off Meeting.
- Item 2.3.1 shall be manufactured in Aluminium AW-6082 AlSi1MgMn instead of POM-C as reported in 107-051504_AB0001a_2022-03-30_Abschlussdeckel.pdf.
- The item 2.3.2 shall be procured in FKM (Viton) material.
- Item 2.3.3 it will be changed to 4-pin connector, and all details will be provided along with assembly 2.3.
- Item 2.3.4 it may be affected by the changes in assembly 2.3. All details will be provided along with assembly 2.3.
- Item 2.3.5 it may be affected by the changes in assembly 2.3. All details will be provided along with assembly 2.3.
- Assembly 2.3.6 it may be affected by the changes in assembly 2.3. All details will be provided along with assembly 2.3.

2.3.3 Customer supplied components

The Contract must procure all the parts listed in Section 6, except the item labelled “Schrittmotor” (Part 2.2.1.1.4.1, Part 2.2.1.1.4.2, Part 2.2.1.1.4.3), i.e. the stepper motor with the associated cables and connector. AD04 includes the related drawing to infer the interfaces.

2.3.4 Labelling and marking

For the marking of the single actuators, it is necessary to refer to drawing 107-051517_2021-10-21.pdf, which is included in AD01. The label's details to be marked need to be defined in agreement with INAF before the first prototypes production.

The actuators are all labelled with a unique human and machine-readable serial number. A simple QR code reader is sufficient to extract all information from the QR code. Information can, e.g. be fed directly into a database (e.g. together with the mirror and its position in the telescope's structure). Figure 8 shows an example of the label. The serial number is coded to contain the version of the actuator mechanics, a unique continuous integer number, the date of production and the producing institution. The format used is:

v-nnnnnn-yy/mm-ppp

- v: is the version (for this contract, the version is D)
- nnnnnn: serial number made of 6 numbers
- yy/mm: year/month of production (e.g. 24/04)
- ppp: name of the institute (for this contract is INF)

Figure 2.2 Example of an actuator QR Code (D-012345-18/04-UZH)

2.4 ASSEMBLY OF COMPONENTS

2.4.1 Drawings list and sequence

The actuator needs to be entirely assembled in such a way it will become a single product (LRU). In Section 6, the items labelled "Assembly" are indicated as assembly in the "Component type" column. Details of assembly and mounting procedures for the sub-assemblies are provided in the "Reference Filename" column; these files are included in AD03.

It is necessary to highlight that the following files:

- 11_Komplettierung_AMC_kpl_v2_2021-10-05.pdf included in AD01
- Vorschriften und Anweisungen_2022-08-12.pdf included in AD01

must be used to complete the assembly of a single actuator.

2.5 ACTUATORS TEST

2.5.1 Test execution description

The scope of the test is reported in the following table:

Step	Description	Percentage of test samples
#1	Mass measurement [kg]	100%
#2	Functional test: - MAC address verification - continuous readout of current, temperature and humidity - run-in test with 10 cycles with no load	100%
#3	Water tightness test - immersion on 1m deep water for 30 minutes - drying up for 24h - continuous readout of current, temperature and humidity for 5 minutes	25% Distributed on the entire production
#4	Hysteresis test: - measurement of hysteresis curve in one position - continuous readout of current, temperature and humidity	10% Distributed on the entire production
#5	Stress test: - run-in test with 100 full stroke cycles and load of ±150N - continuous readout of current, temperature and humidity	10% Distributed on the entire production
#6	Repeatibility test: - repeatability test under load of ±150N with this sequence: a. moving to 10 positions retrieving dial gauge readout b. run-in test with 10 full stroke cycles and load of ±150N c. run-in test with 40 reduced stroke cycles and load of ±150N d. moving to 10 positions retrieving dial gauge readout - continuous readout of current, temperature and humidity	10% Distributed on the entire production
#7	Hysteresis test after repeatabillity test: - measurement of hysteresis curve in one position - continuous readout of current, temperature and humidity	10% Distributed on the entire production

2.5.2 Additional details about the tests to be performed

The tests must be executed following the procedures included in:

- Test under load (details in the document: Betriebsanleitung_Einlauftest_Last_v1.0_2022-09-21.pdf)
- Play measurement (details in the document: Betriebsanleitung_Spielmessung_v3.0_2022-04-08.pdf)
- Temperature and humidity measurement during tests (details included in the document: Betriebsanleitung_Temp_Hum_2022-06-07.pdf)

The description of a system able to test actuators is included in:

- Operative manual of test device (details in the document: Bedienungsanleitung – 20211116.pdf)
- Annexes to the operative manual of test device (details in the document: Anhang zur Bedienungsanleitung.pdf)
- List of commands reported in section 5.

This device was validated with a commissioning session described in:

- Betriebsanleitung_Erstinbetriebnahme_v2.0_2022-06-07.pdf

2.5.3 Customer-supplied test equipment

The Contractor is required to procure, install and operate at all the systems necessary for testing, except for the actuator control SW that will be provided by INAF.

3 WORK TO BE PERFORMED

3.1 OVERALL ORGANIZATION

3.1.1 Key personnel

To execute the activities described in this document, the Contractor must appoint the following key personnel:

- A Project Manager who is responsible for the execution of the entire work.
- A Technical point of contact who shall manage the Product Assurance, the quality, and the configuration for the product's correct traceability.

3.1.2 Meetings, reviews, and notes

The Contractor is required to provide a plan for recurring meetings and reviews, which will be refined at the KOM meeting with the INAF Responsible for the Contract (RUP, “Responsabile Unico del Procedimento” in Italian). The RUP must be kept updated throughout the entire duration of the project. Once the plan is agreed upon, the Contractor will be responsible for organizing the meetings as planned. For each meeting, the following documents must be produced at least:

- Agenda with the points to be discussed, which must be agreed upon with the RUP and provided at least one week in advance.

- Presentation and valuable material for the meeting, which must be agreed upon in advance with the RUP.

- Meeting minutes that contain the topics discussed, salient interventions, and resulting actions.

In addition to the reviews, a remote meeting will be scheduled every two weeks between the contact technical point of contact and the WP manager (coordination meeting). Only the RUP will have the right to cancel or postpone the meeting for any reason.

To summarize, the following meetings must be guaranteed throughout the project:

- Coordination meeting – On a bi-weekly remote basis.

- Extraordinary meetings – Based on needs (urgencies, critical issues).

- Review Meeting – Based on the Milestones table and in attendance.

In case an official communication needs to be made regarding a technical or managerial matter, both parties will use the "Note" as indicated in paragraph 4.3.4.

3.1.3 In case an official communication needs to be made regarding a technical or managerial matter, both parties will use the "NoteCost and project duration

The all-inclusive cost for the supplies and services covered by this work is established in Euros **1.300.000,00** (one million and three hundred thousand/00) plus legal VAT and is to be intended as the maximum price foreseen for the scope of this supply.

The assignment will have a duration of **15 months, effective** from the signing of the contract. The KOM will take place immediately just after the formalization of the contract.

The amount will be paid on a milestone basis upon presentation of an appropriate invoice and with the authorization of the RUP, through an official Note.

3.2 MILESTONES E REVIEWS

The development of the project related to the supply will be monitored in stages to verify that the activities are performed as planned and to prevent any issues that may arise during construction. Each stage will include a review where the project's main indicators (schedule, costs, risks) will be evaluated, validated for invoicing purposes, and discussed to determine the next steps. The table below summarizes the stages and their objectives.

Milestone ID	Review	Obiettivi	Schedula
KOM	Kick-Off Meeting	Start of activities	T0+1month
PRT	Prototypes	Construction, integration and test for the first 2 sets of actuators	T0+3months

Milestone ID	Review	Obiettivi	Schedula
IRR1	Integration Readiness Review 1	Production and procurement for all the subsystems necessary to integrate 200 sets of actuators (prototypes excluded)	T0+6 months
TRR1	Test Readiness Review 1	Integration, production, and test of the first 200 sets of actuators (prototypes excluded)	T0+8 months
TRR2	Test Readiness Review 2	Integration, production, and test of the remaining sets of actuators	T0+13 months
CCM	Closure of Contract Meeting	Completion of tests on the remaining sets of actuators and Shipping of actuators (Europe)	T0+15months

4 ANNEX 1 - DOCUMENT REQUIREMENT DESCRIPTION (ENGLISH)

4.1 DOCUMENT TYPE

The Contractor is required to provide all the necessary documents to meet the milestone requests specified in the dedicated milestone summary table, as described in section 3.2. The documents must be categorized based on their type and intended use. The following table provides guidelines for addressing the content of each document.

Type	Acronym	Description
BOM	Bill Of Material	Bill of material for assembly drawings.
CRE	Change REquest	This type of document is necessary to keep traceability of all requests of change for the project. See 4.4.6.
DWG	Drawing	2D manufacturing drawings.
ICD	Interface Control Document	Documents providing interface details.
LIS	LISt	This type of document must be used when items, activities or deliveries must be put in list form (exception is foreseen for Bill Of Material). For example, drawing list, documentation status list or configuration item data list, cost work or product breakdown, compliance matrix, action item list etc.
MAN	MANual	This type of document outline the way an item, an assembly or the entire telescope should be used and/or maintained.
MDL	MoDeL	This type of document is referring to all models used to demonstrate compliance to specifications such as (but not limited to): • 3D CAD (native and neutral) • Finite Element Models (FEM) • Mathematical models (eg Simulink, MatLAB etc.) In case models include more files they can be collected in compressed format with, in addition, a text file (.txt) which list the entire content.
MOM	Minute Of the Meeting	See section 4.3.2.
MPR	Monthly Progress Report	See section 4.3.3. Not foreseen for this contract!
PLA	PLAn	See chapter 4.2 to refer to all documents which provide planning of the work, including schedule.
PRO	PROcedure	Documents to provide step by step procedures for: • assembly/disassembly • maintenance

Type	Acronym	Description
		• inspection • tests
TRE	Technical REport	Document which reports: • Design descriptions, • Model descriptions, analyses and relative results. • Inspection results • Test results They are the instrument to demonstrate the requirements compliance.
NTE	NoTE	A short document reporting a topic of managerial or technical nature. Normally are used for official communications.
NCR	Non-Conformance Report	This type of document is necessary to keep traceability of all non-conformances for the project. See section 4.4.3.
RFD	Request For Deviation	This type of document is necessary to keep traceability of all requests for deviation for the project. See 4.4.4.
RFW	Request For Waiver	This type of document is necessary to keep traceability of all requests for waiver for the project. See 4.4.5.
SLI	SLIdes	Presentation including any type of technical and/or managerial info
SPE	SPEcification	Document which specifies the technical requirements to be satisfied by the work.
SOW	Statement Of Work	Document stating the scope of a work.

MOM, RFD, RFW, CRE, NTE, and NCR shall have a dedicated lighter template (see dedicated document description section) to be documents with only the pages necessary for the content to be light and easy to read.

The Contractor will produce all templates and format that will be approved by INAF PO at Kick-Off Meeting.

Written documents (not models, like CAD, FEM, Servo etc.) shall be produced in English and, unless otherwise specified, shall be provided always in pdf format.

Models shall be provided in native format and complete as needed to run and/or upgrade the telescope for its entire life time.

4.1.1 Revisions and drafts

Draft versions of documents will necessarily have the suffix to revision with “D” and a sequential number with two digits.

4.1.2 Documents coding

For all documents - except drawings and bill of materials - the code will have the following coding (draft versions will have the extension included between brackets):

LSTS-TTT-XXXX-0000-RR(D00)

- LSTS → Large Sized Telescope at South site.
- TTT → Type of documents as per table above.
- XXXX → Organization
- 0000 → Sequential four-digit number (every document type from each organization will start from 0001)
- RR → double digit number to identify the revision, extended of “D00” when in draft version

For all the drawings or bill of materials the code will have the following coding (draft versions will have the extension included between brackets):

LSTS-DWG-XXXX-000000000-RR(D00)

- LSTS → Large Sized Telescope at South site.
- DWG or BOM → Drawing or Bill Of Materials.
- XXXX →Organization
- 000000000 → Configuration item number made of 9 numbers (taking into account 7 assembly levels and 2 last digits for items included in the assembly).

RR → double digit to identify the revision, extended of “D00” when in draft version.

4.1.3 Disclaimer for documents

Each document produced within the effort described within this SoW shall include the following disclaimer: “LST-South is funded by European Union – “NextGenerationEU”. The points of view and the opinions are only those of the authors and do not necessarily reflect those of European Union or European Commission. Neither European Union nor European Commission can be held liable for those.”

4.2 ACTUATORS PRODUCTION PLAN

4.2.1 Procurement plan

The procurement plan for the LST-S Project should outline the major activities planned for purchasing and/or manufacturing the product. It should also include the associated activities for inspection, pre-assembly, and testing of the items, starting from the components up to the parts and assemblies that complete the entire product. The following minimum set of topics should be covered:

- Manufacturing process qualification: explaining how the manufacturing process capability will be selected, achieved, and maintained.

- Manufacturing facilities and location (including sub-suppliers) including a description of the type of production, types of machinery available, etc.
- Expected procurement block diagrams when single activities on the same assembly involves more suppliers (e.g. Raw material purchase by supplier A → Manufacturing by Supplier A → Welding by Supplier B → Thermal treatment by supplier C → Coating by supplier D → Assembly in house).
- Transportation details between different sub-suppliers.
- Expected manpower during execution.
- Constraints on procurement or deliveries.

4.2.2 Assembly plan

The factory assembly plan should outline the step-by-step process for assembling and integrating the telescope. A PERT diagram may be used to aid in this process. The plan should include all the necessary steps for assembling sub-systems and integrating them onto the telescope. It should also specify the essential procedures for alignment, inspections, and checks, including all critical operations that will be performed during the assembly process. Additionally, the plan should provide a detailed list of all the required components and materials for the assembly.

- Handling equipment.
- Standard tools and machines.
- Special assembly tools.
- Available measuring and alignment equipment.
- Manpower (amount, qualifications and categories).
- Office and workshop features.

4.2.3 Test and Inspection Plan

The test and inspection plan should include a table that lists unique labels for each inspection and test title.

The tests and inspections descriptions shall be in paragraphs named “Test and Inspection Title” and shall contain the following set of information, as a minimum:

- Unique dentification label.
- Reference to the requirements covered.
- Assembly Level (e.g. product tree level) and the configuration (e.g. involving dummies).
- Description and objectives.
- Inputs, outputs.
- Success criteria.
- Authority performing the test/inspection (e.g. Test Engineer, etc.).

4.2.4 Test and inspection procedure

The Test and Inspection Procedure should include all the necessary steps to conduct verifications as outlined in the Inspection and Test Plan (refer to section 4.2.3). As a minimum, the Test and Inspection Procedure should provide the following information:

- Reference to Test and Inspection Plan unique identification code and title.
- Reference to the requirements covered.
- Applicable and reference documents
- Test and Inspection Conditions to perform the Test or Inspection correctly (e.g., special environmental conditions, dedicated tools, calibration requirements, etc.).
- The test and Inspection Procedure description is to be executed to grant the verification. The pass/fail criteria (if any) shall be stated explicitly for each step.
- Test and Inspection Results Presentation description to process the raw data for the final report where applicable.

4.2.5 Packing and Shipping Plan

This plan shall identify all the transportation phases and the unloading/loading milestones for transportation of the product from the Contractor's premises to the final site in Chile. The document shall have a first section which shall describe the following:

- Packaging means shall be identified, highlighting the rationale used for selecting the packaging type (fragile items, etc.)
- Types of code markings that will be used, marking information (e.g. fragile/delicate, arrows, hazardous warning labels, use no hooks labels, etc.)
- Handling means indicating handling tools (if applicable).
- Storage means.
- Loading/Unloading Operations.
- All supervision activities that will be taken to verify that the products are correctly presented, properly handled, and safely secured on the means of transport.

The second section shall focus on the shipment plan proper, with identification of the major shipment, loading and unloading points, transportation means anticipated, schedule etc. Furthermore, it shall be detected, listed, and analyzed the areas that might cause or entail delays. For this reason, a risk register shall be updated, and references provided.

4.2.6 Schedule

The document shall contain the Master Schedule of the project which includes the activities/tasks in Gantt Chart form with:

- the dependencies between activities
- an up-to-date status of the Project and the critical path highlighted,
- the percentage of task completion,

- the buffer time explicitly stated,
- the identification of normal working conditions (working and non-working periods).

4.2.7 Risk management plan

The document shall contain the following minimum set of information:

- Project objectives (in terms of cost schedule in order to assess the scoring scheme).
- Risk scoring scheme (severity and likelihood).
- Risk index definition (based on the risk scoring scheme).
- Mitigation actions (based on Risk index).
- Risk acceptance criteria.
- Risk comparison methods (to assign risk priorities).
- Risk monitoring (risk assessment and risk register).

4.2.8 Risk register

The Risk Register should include a list of all the risks related to the project that have been identified during the contract execution. The Risk Register should be updated regularly and sent to the INAF PO along with the Progress Report. It should contain, at a minimum, a table format that lists:

- A unique risk identification reference.
- Risk source originator (e.g. Progress Meeting Review, etc.)
- Risk identification date.
- Description of the risk.
- The risk owner.
- Risk index (assessed as indicated in Risk management plan).
- Status (e.g. open, mitigated, occurred, retired).
- The current prevention/mitigation actions identified.
- The due date for the implementation of prevention/mitigation action foreseen.
- Mitigated risk index.

4.3 MONITORING DOCUMENTATION

4.3.1 Action Item List

The Contractor shall be responsible to track the actions discussed during the development of the work. Those should be enclosed in a document in list form with at least the followings:

- Unique id for the action.
- Action source: minute, note or email.
- Description.
- Responsible of the action
- Due date/closure date (closure date can replace due date or it can have a dedicated field).
- Solution source: minute, note or email.

- Action status (open, closed, retired).

The list shall be always available for INAF PO (in shared mode).

4.3.2 Agenda and Minute of Meetings

Each meeting foreseen in the scope of this work needs an agenda of topics to be discussed. The Contractor shall at least:

- Send the agenda via email in advance in function of the meeting type,
- Provide a list in bullet form with the description of topic to be discussed.

During the development of this work, for each meeting the Contractor shall produce a relative minute in a simplified template to grant correct traceability. This document needs:

- To include the agenda sent via email.
- To include participants.
- To include clearly:
  - actions with due date and responsibility,
  - decisions,
  - statements.

Each minute needs to be approved and signed by all parties involved at the end of the meeting unless otherwise decided by INAF PO.

4.3.3 Monthly progress report

The Contractor is responsible for submitting written monthly progress reports. These reports should be sent via email and should detail the progress made and activities carried out in the previous month. This includes any model images, analysis outputs, and pictures, among others.

The report should also describe the status of any action items, highlighting the number of open and closed items. Additionally, it should include the status of any project audit (PA) items such as non-conformance reports (NCRs), requests for deviations (RFDs), requests for waivers (RFWs), and corrective and preventive actions (CREs).

The Contractor should also report on any major risks that arise and the measures taken to mitigate them. Finally, the report should provide a look-ahead of the major activities and tasks planned for the upcoming month. The Contractor should attach an up-to-date schedule, action item list, and risk register with the report.

4.3.4 Note

The Note is a short document/letter reporting a topic of managerial or technical nature normally used for official communications. Typical examples of use are:

- Notification of successful completion of milestone.

- Notification of a major problem that has the potential to seriously affect the performance of the Contract and demand immediate knowledge and attention of the parties.
- Notification of an opportunity to improve performance, cost and/or schedule.

The Note must have a simplified template indicating the originator, the recipient, and the content description.

4.4 PRODUCT ASSURANCE DOCUMENTATION

4.4.1 Product assurance plan

The product assurance plan shall present the project product and Quality Assurance organization, methods, tools, and procedures that the Contractor intends to implement for the project. The document shall contain the following information as a minimum:

- Quality Assurance (QA): functions organization and work tasks.
- QA description procedures related to the work phase and product.
- Configuration management: link to the Configuration Management Plan.
- Reviews and Audits: Scheduled and non-scheduled.
- Sub-tier Contractors Control: Assurance that requirements, standards, and controls imposed on the equipment manufacturers are also imposed on the lower-tier manufacturers as applicable.

4.4.2 Configuration management plan

The Configuration management plan shall outline the organization and the means (methods, tools, and procedures) throughout it is necessary to handle product changes and the interfaces internal and external to the Project. Based on this plan, a Configuration management system shall ensure that:

- The manufacturing documentation is in line with the design documentation.
- The product is in line with the manufacturing documentation.
- Required design, item or component and/or manufacturing non conformance, deviation waiver or change is properly analyzed approved and documented to be established by the Contractor and agreed by INAF PO.

Finally, the configuration management plan shall address as a minimum:

- Configuration management responsibilities and authorities.
- Configuration control and change process (NCRs, RFDs, RFWs and changes).
- Configuration identification and status accounting.
- Configuration Audits.

4.4.3 Non-conformity report

During the project development, the Contractor must report any non-conformance to the INAF PO immediately. No remedy shall be allowed until approval is granted from INAF PO. The formal contract change request process is detailed in the contract.

The Non-Conformity Report shall include in a schematic, simplified template a set of information equivalent to the one listed here below:

- Initiator and date of detection.
- The reference of the requirement, document, or item (CI and serial number).
- The description and reason of the NCR observed.
- Analysis of the root cause and if it is recurring.
- Effect description.
- The decision about addressing the non-conformance (action, rejection, implementation of RFD, RFW or CRE).
- Approval (e.g., by INAF PO) of the decision proposed.
- Verification by PA.
- Closure.

4.4.4 Request for deviation

During the project development, the Contractor may submit a Request for Deviation before the manufacture of an item seeking a planned variance from specified requirements.

The minimum set of details is equivalent to the one outlined in the RFW section; in the RFD case, the corrective action is not foreseen as the deviation is not submitted after manufacturing.

4.4.5 Request for waiver

During the project development, the Contractor may submit a Request for Waiver to accept an item which, during manufacture or after inspection, was found to depart from specified requirements, but is considered suitable for use as is or after rework by an approved method. Each waiver shall be allowed once reviewed and granted by the INAF PO.

A RFW shall include in a schematic, simplified template the following information as a minimum:

- Initiator information.
- Configuration Item (CI) to be covered by the waiver.
- Serial number of the affected instances or batch number, etc.
- The affected Documents/Drawings/Requirements.
- The description and reason of the RFW.
- Impacts on:
  - technical aspects such as feasibility, function, performance, reliability, maintainability or interfaces.

- Schedule of key milestones (including detailed schedule of the change implication).
- Costs (giving detailed information on the manpower, material, cost etc. and reflecting the differential cost for changes in work packages).
- Safety of the system.

- The corrective action taken by the Contractor.
- The price concession proposed by the Contractor.
- Additional documents as needed to justify the RFW (e.g. NCR).

4.4.6 Change request

Any changes or non-conformance that affect technical requirements, schedule, or cost shall only be authorized through written notification from the INAF PO contractual point of contact and the Contractor. The formal contract change request process is detailed in the contract document. Issues not affecting performance, schedule, or cost will be addressed individually.

A CRE shall include in a schematic, simplified template at least the following information:

- Initiator information.
- Affected Configuration Items (CIs).
- Affected Documents/Drawings/Requirements.
- The description of the change by means of a clear indication by quoting the old and proposed new versions of the document text or the drawing.
- The reason for the change and expected benefits.
- Impacts on:
  - technical aspects such as feasibility, function, performance, reliability, maintainability or interfaces.
  - Schedule of key milestones (including detailed schedule of the change implication).
  - Costs (giving detailed information on the manpower, material, cost etc. and reflecting the differential cost for changes in work packages).
  - Safety of the system.
- Additional documents as needed to justify the CRE (e.g. NCR).

4.4.7 Configuration Item Data List

The Configuration Item Data List (CIDL) shall list all the up-to-date applicable documents relative to a specific CI at one moment in time of the project. It shall contain as a minimum:

- CI identification (part number and serial number - where appropriate).
- List of the technical specifications.
- List of the ICDs.
- List of the design/analysis reports.

- List of the drawings.
- Bill of Material (BoM).
- List of plans.
- List of procedures.
- List of manuals.
- Quality books.
- List of software.
- List of NCRs and already approved RFDs/RFWs, CREs.

All documents shall be recorded in the CIDL as a minimum with their code, issue, title and release date.

4.4.8 Test and inspection report

The test and inspection report shall summarize and present the results and findings of the procedures outlined in section 4.2.4, including the following information, as a minimum:

- Test and inspection plan unique label and title.
- Test and inspection conditions (e.g. place, environmental conditions, dedicated tools, calibration certificates, etc.).
- Test/Inspection results processed in such a way that they will be directly comparable with the verification items verified.
- A comparative table shall resume the actuals versus the nominal ones required.
- In case of non-compliances, the reference to the related NCRs shall be provided.
- Personnel involved for execution and approval from both parties.
- Appendix: list of attachments of raw data (if applicable).

4.4.9 Quality books

The quality books shall be used to have the entire traceability of the HW and SW produced. In function of the phases they shall include at least the followings (but not limited to):

- Material certificates.
- Thermal Treatments certificates.
- Welding certificates (operators, standard procedures, NDT certificates).
- Coating certificates (Surface treatments, paint thickness, etc.).
- Dimensional and/or alignment checks and relative latest calibration certificates for measuring tools and machines.
- Visual inspections certificates.
- CE certificates.
- Bolt torque certificates.
- RFWs, NCRs.

5 ANNEX 2 - COMMAND SET

5.1 GENERAL COMMENTS

The following notes should be considered:

- All commands are case sensitive.
- All commands need to be fully sent correctly within 2 seconds, starting from entry of the first
- character. Exceeding the time will result in a reset of the internal state machine (no movement of the actuator involved).
- An actuator reset does not change the position of the actuator but only resets the internal state machines.
- No carriage return (CR) should be sent at the end of a command.
- Switching DEBUG-mode on/off influences the amount of data being returned by an actuator.
- Number entries marked as <XX> represent 2 digit 8 bit hexadecimal (0..9,A..F) values.
- Number entries marked as <XXXX> represent 4 digit 16 bit hexadecimal (0..9,A..F) values.
- Number entries marked as d represent a decimal (0..9) value , ex.g. dd □ two digit decimal, ddd □ three digit decimal
- Number entries marked as <DEZ> represent a decimal (0..9) value without leading zeros and optional with a minus. Ex.g. “102”, “3”, “-45”, “0”
- All return messages terminate with <CRLF> or in hex 0x0D 0x0A.
- If the actuator is driven into a jammed position it will automatically send a ‘# JAMMED’ message.
- All log messages are send in the format “# The Log Messages” + <CRLF>
- Each command gets a response:
    - OK<CR LF> → command successfully processed
    - BUSY<CR LF> → motor busy, command could not be processed
    - UNKNOWN<CR LF> → command unknown

5.2 FORMAT OF POSITION FRAME

The format of the position frame is given as:

aabb ccdd eeff gghh ii jj (CR LF)

Value	Description
aabb, ccdd, eeff, gghh	16-bit hexadecimal values of ADC sensors [1..4], used for debug purpose only
ii	mm value of position (hexadecimal)
jj	sub-mm value of position (multiples of 1/256th mm, hexadecimal)

Example: Sending the command p returns the position frame 01D6 0099 0306 0241 12 10 03, which corresponds to h12 = d18 and h10 = d16 (ignore everything but ii and jj). The absolute position is hence 18.06(25) mm.

5.3 FORMAT OF CALIBRATION TABLE FRAME

The format of the position frame is a comma separated text able, column separator "," and row separator <CRLF>.

Value	Description
step	16-bit hexadecimal values of ADC sensors [1..4], used for debug purpose only
adc0,adc1,adc2,adc3	Raw adc value of hall sensors 0..3
Angle	8 bit decoded angle sensor value (0..255 → 360°)

Example:

step,adc0,adc1,adc2,adc3,angle

0,1251,1156,789,1266,144

200,1247,1121,863,1265,144

400,1242,1075,972,1264,144

600,1236,1017,1098,1264,144

800,1227,946,1228,1262,144

1000,1216,869,1358,1261,144

1200,1200,800,1487,1259,145

1400,1181,762,1609,1256,145

5.4 COMMANDS

Command Syntax	Description	Return value (DEBUG mode ON/OFF)
l	drive one step inwards (5 µm)	`OK<CRLF>` or `BUSY<CRLF>`
L	drive one turn inwards (1 mm)	`OK<CRLF>` or `BUSY<CRLF>`
r	drive one step outwards (5 µm)	`OK<CRLF>` or `BUSY<CRLF>`
R	drive one turn outwards (1 mm)	`OK<CRLF>` or `BUSY<CRLF>`
<	Drive inwards until jammed or character received	`OK<CRLF>` or `BUSY<CRLF>`
>	Drive outwards until jammed or character received	`OK<CRLF>` or `BUSY<CRLF>`

Command Syntax	Description	Return value (DEBUG mode ON/OFF)
Pxxyy	Programmed drive: goto position xxyy with xx being in units of 'mm' and yy in units of 1/256th of 1 mm. All values are hexadecimal. (*)	`OK<CRLF>` or `BUSY<CRLF>`
#	Re-calibrate actuator: drive all inwards until mechanical limit, rewrite internal lookup table (LUT)	`OK<CRLF>` or `BUSY<CRLF>` Returns dump of lookup Table at finish

V	Print version number	Returns version string, ex.g.
		`# AMC Motor Firmware Version 2 compiled Nov 28 2023 15:04:38<CRLF>`
		`OK<CRLF>`

?	Print help screen with all commands	Returns log strings and `OK<CRLF>`
		`# h print humidity`
		`# ! toggle debug mode`
		`# ? Help`
		`OK`

Dddd	Set motor step speed in steps per Second. valid values 1..700	`OK<CRLF>` or `ERROR<CRLF>` Returns "error" if speed is to high
d	Read back delay	`delay=<DEZ><CRLF>` `OK<CRLF>`
m	print calibration table	<calibration table frame> `OK<CRLF>`

T	Read internal temperature of actuator	`temperature=<DEZ><CRLF>`
		`OK<CRLF>`
		returned value is in celsius degree. Example: "`temperature=27`"

H	Read internal humidity of actuator	`humidity=<DEZ><CRLF>`
		`OK<CRLF>`
		returned value is in celsius degree. Example: "`humidity=27`"

Gxx	Goto position associated with elevation angle xx from elevation lookup table. Returns error, if elevation table is not programmed.	`OK<CRLF>` or `ERROR<CRLF>`
!	Toggle DEBUG mode. In Debug mode all debug messages are send in log format ex.g. `# log or debug message<CRLF>`	`debugmode=on|off` `OK<CRLF>`
p	Print current position	Position frame

Command Syntax	Description	Return value (DEBUG mode ON/OFF)
$	print elevation lookup table	*TBD*
s	Stop motor. Any driving job is instantly stopped.	OK<CRLF>
C	Cycle test: 3mm right and 3mm left	OK<CRLF> or BUSY<CRLF>

(*) The full stroke of the actuator is 36 mm. 1 mm at each end of this range is used for calibration purposes only. The useable range is hence 34 mm. It is not possible with the P-command to drive the actuator outside of the 34 mm region. The first six commands (driving manually with L,l,R,r,<,>) allow to drive outside of the 34 mm and into the actuator's limits and should only be used by experts and with care.

6 ANNEX 3 – PART LIST

The part list here below is reported in AD03.

Item	Component Type	Part Number	BOM Structure	QTY	Description	Company	Reference Filename
1	Assembly	FL001	Normal	1	Flanschlager komplett		03_Flanschlager_kpl_2021-09-21.pdf
1.1	Part	FL0001	Normal	1	Sockel_Flanschlager		FL0001_Sockel_Flanschlager.pdf
1.2	Part	FL0002	Normal	1	Gewindering		FL0002_Gewindering.pdf
1.3	Assembly	Fluro GE 16 EC-NIRO	Purchased	1	Gelenklager Radialspiel C1	Fluro	
1.4	Part	Bossard 1234196	Purchased	1	Innensechskantschraube M6x20 DIN 912	Bossard	
1.5	Part	Brütsch-Rüegger 839923.0550	Purchased	2	Oetiker Bride 7x45.3-48.5	Brütsch-Rüegger	
1.6	Part	Brütsch-Rüegger 860110.2810	Purchased	1	O-ring di36x3 (**To be procured in FKM - VITON**)	Brütsch-Rüegger	
1.7	Part	FL0003	Normal	1	Zentrierstueck		FL0003_Zentrierstueck.pdf
1.8	Part	FB0001	Normal	1	Faltenbalg Spritzguss	Franksa FBZ0064 (nach Zeichnung 0366 Index 1)	FB0001_Faltenbalg_Spritzguss.pdf
1.9	Part	Bossard 1233920	Purchased	4	Innensechskantschraube M4x16 DIN 912	Bossard	
2	Assembly	107-051500-017	Normal	1	AMC komplett		
2.1	Assembly	Rohr_Abdeckung_mit_Feder_Clip_verriegelt	Normal	1	Rohr_Abdeckung_mit_Feder_Clip_verriegelt		

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Item	Component Type	Part Number	BOM Structure	QTY	Description	Company	Reference Filename
2.1.1	Part	107-051517 (A0004)	Normal	1	Rohr-Abdeckung		107-051517_A0004_2022-03-30_Rohr-Abdeckung.pdf
2.1.2	Part	A0005	Normal	3	Feder-Clip_verriegelt		A0005_Feder_Clip_verriegelt.pdf
2.1.3	Part	Bossard 1245074	Purchased	3	Zylinderschraube M2.5x6	Bossard 1245074	
2.2	Assembly	Fixieren_der_Motoreinheit	Normal	1	Fixieren_der_Motoreinheit		
2.2.1	Assembly	M001	Normal	1	Motoreinheit		05_Motoreinheit_kpl_2021-09-21.pdf
2.2.1.1	Assembly	Montage_Motorsteuerung	Normal	1	Montage_Motorsteuerung		
2.2.1.1.1	Assembly	M003	Normal	3			
2.2.1.1.1.1	Part	M0002	Normal	1	Distanzbolzen		M0002_Distanzbolzen.pdf
2.2.1.1.1.2	Part	Bossard 1178857	Purchased	1	Gewindestift - Inbus_Stiftschraube_M2x10	Bossard	
2.2.1.1.2	Assembly	Motorsteuerung	Inseparable	1			9471-01_standard_PlacePlan_Top.pdf 9471-01_standard_PlacePlan_Bottom.pdf amc_mainboard_r1b_schematic.pdf BOM_9471-01_Master.pdf
2.2.1.1.3	Part	Bossard 1233688	Purchased	3	Innensechskantschraube M2x6 DIN 912	Bossard	
2.2.1.1.4	Assembly	Motor_komplett_Kabel_angeschlossen	Normal	1	Motor_komplett_Kabel_angeschlossen		
2.2.1.1.4.1	Part	Stecker_Motorkabel	Purchased	1			
2.2.1.1.4.2	Part	Oriental_Motor_C026Q_9012K	Purchased	1	Schrittmotor		
2.2.1.1.4.3	Part	Motorkabel_angeschlossen	Purchased	1			
2.2.1.1.4.4	Part	SP0003	Normal	1	Mitnehmer (**To be changed with Huco coupling 232.13**)		SP0003_Mitnehmer.pdf

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Item	Component Type	Part Number	BOM Structure	QTY	Description	Company	Reference Filename
2.2.1.1.4.5	Part	Bossard 1178989	Purchased	2	Gewindestift - Inbus_Stiftschraube_M3x5	Bossard	
2.2.1.1.4.6	Assembly	M002	Normal	1	Winkeldecoder_komplett		
2.2.1.1.4.6.1	Part	M0003	Normal	1	Winkeldecodermagnethalter		M0003_Winkeldecodermagnethalter.pdf
2.2.1.1.4.6.2	Part	BMN-35-H (NdFeB)	Purchased	1	Winkeldecodermagnet - magnetisiert	Bomatec	
2.2.1.1.4.7	Part	Bossard 1233807	Purchased	1	Innensechskantschraube M3x10 DIN 912	Bossard	
2.2.1.1.5	Part	M0001	Normal	1	Motorhalterung		M0001_Motorhalterung.pdf
2.2.1.1.6	Part	Bossard 1233815	Purchased	4	Innensechskantschraube M3x12 DIN 912	Bossard 1233815	
2.2.1.2	Assembly	Hallsonde_komplett_Montage	Inseparable	1	Hallsonde_komplett_Montage		04_Hallsonde_kpl_2021-09-21.pdf Hallsonde_PCB_Drawing_Series_v06.pdf hall_sens_schematic_v06_dec12.pdf 11245.FA_QT-Partlist-1.pdf
2.2.2	Assembly	V001	Normal	1	Vorderteil_komplett		
2.2.2.1	Assembly	A001	Normal	1	Aussenhuelse_komplett		02_Aussenhuelse_kpl_2021-09-21.pdf
2.2.2.1.1	Part	A0003	Normal	1	Jum-S-8157146-XXXXX Iglidur J Sondergleitfolie drylin R-JUM-11-25_Gleitfolie ähnlich Kundenbezeichnung R-JUM-11-25	IGUS	A0003_drylin_R_Gleitfolie_JUM_11_25.pdf
2.2.2.1.2	Part	A0002	Normal	1	Nutenstein		A0002_Nutenstein.pdf
2.2.2.1.3	Part	Brütsch-Rüegger 860110.0435	Purchased	1	O-Ring di7x1.5 (**To be procured in FKM - VITON**)		

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Item	Component Type	Part Number	BOM Structure	QTY	Description	Company	Reference Filename
2.2.2.1.4	Part	Bossard 1179020	Purchased	1	Gewindestift - Inbus_Stiftschraube_M3x12	Bossard	
2.2.2.1.5	Part	A0001	Normal	1	Aussenhuelse		A0001_Aussenhuelse.pdf
2.2.2.2	Assembly	Montage_Spindel_Stempel	Normal	1	Montage_Spindel_Stempel		08_Stempel_kpl_2021-09-21.pdf
2.2.2.2.1	Assembly	ST001	Normal	1	Stempel_komplett		
2.2.2.2.1.1	Assembly	Einkleben_Hallsondenmagnet_in_Stempel	Normal	1	Einkleben_Hallsondenmagnet_in_Stempel		
2.2.2.2.1.1.1	Part	Hallsondemagnet	Purchased	1	Magnet Hallsonde (NdFeB)	Webcraft	
2.2.2.2.1.1.2	Part	107-051514 (ST0001)	Normal	1	Stempel		107-051514_ST0001_2022-03-30_Stempel.pdf
2.2.2.2.1.2	Part	Bossard 1179071	Purchased	1	Gewindestift - Inbus_Stiftschraube_ M4x4	Bossard	
2.2.2.2.2	Assembly	SP001	Normal	1	Spindel_komplett		07_Spindel_kpl_2021-09-21.pdf
2.2.2.2.2.1	Part	ST0002	Normal	1	Sicherungsmutter		ST0002_Sicherungsmutter.pdf
2.2.2.2.2.2	Part	SP0002	Normal	1	Spindelmutter		SP0002_Spindelmutter.pdf
2.2.2.2.2.3	Part	Bossard 1254758	Purchased	1	Wellensicherung A8	Bossard	
2.2.2.2.2.4	Part	SP0003	Normal	1	Mitnehmer (**To be changed with Huco coupling 232.13**)		SP0003_Mitnehmer.pdf
2.2.2.2.2.5	Part	Bossard 1254715	Purchased	1	Wellensicherung A5	Bossard	
2.2.2.2.2.6	Part	Bossard 1178989	Purchased	2	Gewindestift - Inbus_Stiftschraube_M3x5	Bossard	
2.2.2.2.2.7	Part	SP0001	Normal	1	Spindel		SP0001_Spindel.pdf
2.2.2.2.2.8	Part	Georg Rutz AG 3200 A-2RS1TN9/C0/FM 222/8%	Purchased	1	Schraegkugellager_Typ_3200A_2Z	Georg Rutz	

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Item	Component Type	Part Number	BOM Structure	QTY	Description	Company	Reference Filename
2.2.2.3	Part	SP0004	Normal	1	Kupplung (**to be changed with Huco coupling 236.13**)		SP0004_Kupplung.pdf
2.2.2.4	Part	Brütsch-Rüegger 860110.0435	Purchased	1	O-Ring di55x1.5 (**To be procured in FKM - VITON**)	Brütsch-Rüegger	
2.2.3	Part	Bossard 1033085	Purchased	4	Innensechskantschraube M3x20 DIN 912	Bossard	
2.3	Assembly	107-051500-016	Normal	1	Abschlussdeckel komplett (**This assembly will have some minor design changes to have a 4pins connector**)		01_Abschlussdeckel_kpl_v2_2021-09-28.pdf
2.3.1	Part	107-051504 (AB0001)	Normal	1	Abschlussdeckel (**To be manufactured in Aluminium AW-6082 AlSi1MgMn**)		107-051504_AB0001a_2022-03-30_Abschlussdeckel.pdf*
2.3.2	Part	Brütsch-Rüegger 860110.0435	Purchased	1	O-Ring di55x1.5 (**To be procured in FKM - VITON**)	Brütsch-Rüegger	
2.3.3	Assembly	Lumberg_Stecker_0314 03_v2	Purchased	1	Lumberg Stecker (**To be changed with 4 pins connector**)	Lumberg Stecker	
2.3.4	Part	AB0002	Normal	1	Verdrehsicherung (**It may be affected by minor changes**)		AB0002_Verdrehsicherung.pdf
2.3.5	Part	AB0003	Normal	1	Powerprint Isolation (**It may be affected by minor changes**)		AB0003_Powerprint_Isolation.pdf
2.3.6	Assembly	Powerkabel_komplett_Montage_v2	Inseparable	1	Powerkabel_komplett_Montage (**It may be affected by minor changes**)		06_Powerkabel_kpl_2021-09-21.pdf

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