Title:

Rosetta Lander
SD2 Subsystem

Specification

Project: SD2 - Rosetta Lander

Contract: ASI – TS

		Function	Name	Signature
Prepared	by :	Engineering	M. Malychev	
	by :			
Checked	by :	Project Leader	P.G. Magnani	
	by :			
Approved	by :	P.A. Manager	M. Colomba	
	by :	Program Manager	E. Re	
Authorised	by :	General Manager	V. Venturini	

Configuration: Management

Rev.:

Date:

Accepted by : _____ _____

CHANGE HISTORY RECORD

Rev. 0 Reviewed by G.L. Camaschella Date 13.10.97

O.M. NA Approved by Date

Change description : First emission.

Rev. 1 Reviewed by G.L. Camaschella Date 09.01.98

O.M. 451 Approved by E. Re Date 09.01.98

Change description : Updating based on 09.01.98 M.o.M comments (accepted because no comments).

Rev. 2 Reviewed by G.L. Camaschella Date 31.01.98

O.M. 451 Approved by E. Re Date 31.01.98

Change description :

Chapter 1 : Carousel "Oven lower supporting ribs" and oven design modification;
"1.3.3. SD2 Base Plate" and "1.3.4. Control Electronics" modified;
Electronics: Temperature sensors #1, #2 and A/D converter (M.o.M. 8-9/01/98) deleted + subsequent updating.

Chapter 2 : Chapter 1 modification subsequent updating;
Oven electric contacts modification + oven electric contacts meaning definition (Medium Temperature Oven electrical contacts similar to High Temperature Oven electrical contacts – not part of SD2);
Definition of Oven position accuracy (paragraph 2.2.1).

Chapter 3 : Chapter 1 modification subsequent power budget updating;
" 3.1.4 Oven electrical I/F " : TBD with MPAe;
"Motor I/F board preliminary component layout" deleted because not needed in this document;
Cables updating subsequent to electronics updating in rev. 1 and rev. 2.

Rev. A Reviewed by G.L. Camaschella Date 04.06.98

O.M. 497 Approved by E. Re Date 04.06.98

Change description: Formal emission.

Chapter 1 : Added RD5 and RD6 documents.
Moved paragraph 1.3. and sub-paragraphs to annex A.1. (updated version with new drawings);
Added new paragraph 1.3. and sub-paragraphs.

Chapter 2 : General updating.

Chapter 3 : General updating.
Added Power and Data Budgets (paragraph 3.3.).

Chapter 4 : General updating.

Chapter 5 : General updating.

Chapter 6 : Paragraph 6.1. completed;

Moved paragraph 6.2. to paragraph 4.3;
Added new paragraph 6.2.

Chapter 7 : Modified Test Plan matrix;
Added Verification Plan.

Chapter 9 : General updating.

Annex 1 : Added.

Rev.	B	Reviewed	by	G.L. Camaschella	Date	26.04.99
O.M.	606	Approved	by	E. Re	Date	26.04.99

Change description: general revision

Rev.	C	Reviewed	by	M. Malychev	Date	19.04.2000
O.M.	706	Approved	by	E. Re	Date	19.04.2000

Change description:

Chapter 1 :
- list of applicable/reference documents updated;
- subsystem overview description updated;
- dry ice and tuff deleted from comet soil characteristics requirement;
- requirement of sample quantity redefined;
- TBDs and TBCs deleted;
- thermal contamination requirement defined.

Chapter 2 :
- unit reference frames defined;
- references to units ICD provided (where applicable);
- Civa-M interface updated;
- Tapping Station interface updated;
- mechanical unit first eigenfrequency changed;
- aperture covers section updated;
- mass budget updated.

Chapter 3 :
- power supply interface defined;
- power consumption definition updated;
- oven electrical interface moved to chapter 2 (tapping station interface);
- housekeeping requirement changed;
- power and data budgets updated;
- Z-Ebox interface connector specified.

Chapter 4 :
- updated following new issue of REID-A;
- ground conditions defined;
- grounding diagram defined.

Chapter 5 :
- requirements redefined.

Chapter 6 :
- references to applicable PA documents provided;
- cleanliness requirement changed.

Chapter 7 :
- model philosophy updated;
- test plan replaced by test definitions;
- Verification Plan update.

Chapter 8 :
- GSE list update.

Chapter 9 : - models section moved to chapter 7;
- set-ups for ground operations provided.
Annex 1 : deleted (will make part of design description documents).

Rev.	D	Reviewed	by	P.Bologna	Date	16.02.2001
O.M.	803	Approved	by	E. Re	Date	16.02.2001

Change description:

- add the SD2 functional requirements
- add the SD2 specific commands requirements
- deleted the TM Rate, TC Rate, TM Volume, TC Volume columns of power consumption table (the data depend on CDMS rates)
- specify the CDMS applicable requirements
- added traceability matrix

Rev.	E	Reviewed	by	M.Malychev	Date	15.05.2001
O.M.	811	Approved	by	E. Re	Date	15.05.2001

Change description:

- SD2 Functional Diagram added
- traceability matrix updated

REVISION INDEX OF SHEETS

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1. GENERAL

ROSETTA is a European Space Agency mission for the study of a cometary nucleus environment and its evolution in the inner solar system.

To enhance the scientific capabilities of the mission, the Orbiter spacecraft will carry one Probe, called ROSETTA Lander, which will land on the comet surface for in situ investigations.

One of the key subsystems of the Lander is the Drill, Sample and Distribution (SD2), a robotics tool able to collect and distribute cometary samples to the on board analysis instruments.

This document defines requirements that shall be met by the SD2 Subsystem.

1.1 DOCUMENTS

1.1.1 Applicable Documents

AD1 Rosetta Experiment Interface Document Part A, ESA Doc., HO-EST-RS-3001/EID A, Issue 1/0.

AD2 Rosetta Lander Experiment Interface Document A REID-A, RO-LAN-RD-3111, Issue 2/0, (with changes of Vibration Test levels defined by:
- DLR e-mail dated 15.11.1999, object: "Clarification: Thermal qualification test requirement"
- DLR e-mail dated 07.03.2000,
- Tecnospazio fax 132-177-2000,
- DLR fax RO-LAN-LT-1500-SU from 16.03.2000,
- DLR document RO-LAN-SP-3302, Issue 1.0 dated 27.03.00.

AD3 Rosetta Lander Verification Program Plan, RO-LAN-PL-3301, Issue: Basic 0, Rev. 0.

AD4 SHARK-MD-TS-013, SD2 Mechanical Unit - ICD drawing; Tecnospazio

AD5 SHARK-MD-TS-086, SD2 Electronic Unit - ICD drawing; Tecnospazio

AD6 SHARK-AB-TS-084; SD2 Subsystem Harness Specification; Tecnospazio.

AD7 SHARK-QA-TS-005, "Product Assurance Plan for SHARK Program.

AD8 SHARK-ICD-TS-043, "CDMS-SD2 Data Interface Control Document".

AD9 MoM "SD2 SW Splinter Meeting", TS, 29-02-2000

AD10 MoM "SD2/CIVA/COSAC/PTOLEMY I/F meeting", TS, 9/10-09-1999

1.1.2 Reference Documents

RD1 "CDMS-Subsystem & Instruments Electrical Interface Definition and Generic Payload Control", Rev. 5;

RD2 SD2D-MD-TS-005/001; SD2 Harness, Cable 1, Drawing;

RD3 SD2D-MD-TS-005/002; SD2 Harness, Cable 2, Drawing;

RD4 Rosetta Lander Common-DPU Flight Model User's Manual

RD5 Rosetta Lander Common-DPU Engineering Model User's Manual

RD6 Rosetta Lander Common-DPU User's Manual (Laboratory Model)

1.2 SUBSYSTEM OVERVIEW

The SD2 subsystem provides microscopes and evolved gas analysers with samples collected at different depths.

The SD2 Subsystem consists of the following components:

- Mechanical Unit
- Electronic Unit
- Software (SW)
- Harness

Accommodation of the SD2 units on the Lander is outlined in the figure 1.2-1.

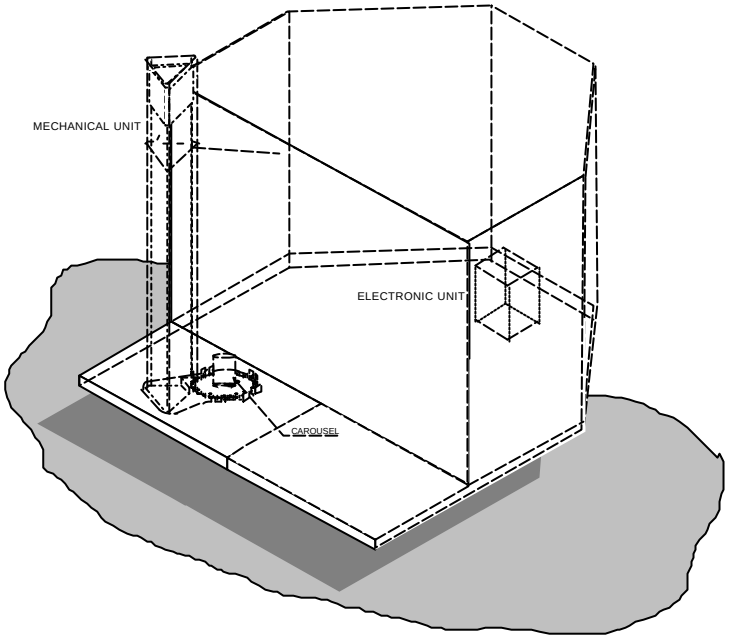


Figure 1.2-1 SD2 units on Lander

The **Mechanical Unit** will be mounted at the Lander Balcony compartment in correspondence with a hole in the Balcony dedicated to the drilling-sampling operations and will perform all electromechanical functions.
The unit will consist of the following main components:
Tool Box, Carousel, Volume Checker, Base Plate.

The Tool Box contains the drill-sampler tool in a protective structural shell (made of CFPR) which assures that no external contamination can reach the tools and the actuators inside.

The drilling and sampling functions are integrated in a unique auger.
In this configuration there is the certainty to collect the sample at the established/measured depth, preventing hole collapsing during extraction or insertion of different tools.
During the final phase of the drilling operation, the sampling mechanism collects the sample.

The sample collected is then delivered to the dedicated containers (ovens) allocated on the rotating disk (Carousel).
The rotation actuator enables the Carousel to mate each oven with the experiment interface positions and the sample feed position.

The Volume Checker measures the volume of the material discharged into the oven.

The Base Plate is mounting plate to allocate the Carousel and the Tool Box.
It provides I/F for Çiva-M, locking its fixed distance from Carousel's centre, and for the Tapping Stations.

The **Electronic Unit** will be installed into the warm compartment of the Lander and will incorporate all electronics to control the Mechanical Unit.
It will provide a HW platform to run the **SW** which implements SD2 functions under higher level control system (CDMS) commands.
The unit will incorporate the Com-DPU processor board developed by DLR for the Lander.

The **Harness** will electrically connect Mechanical and Electronic Units as well as SD2 to Lander's Common E-Box.

Functional Diagram of the SD2 is shown in figure 1.2-2.

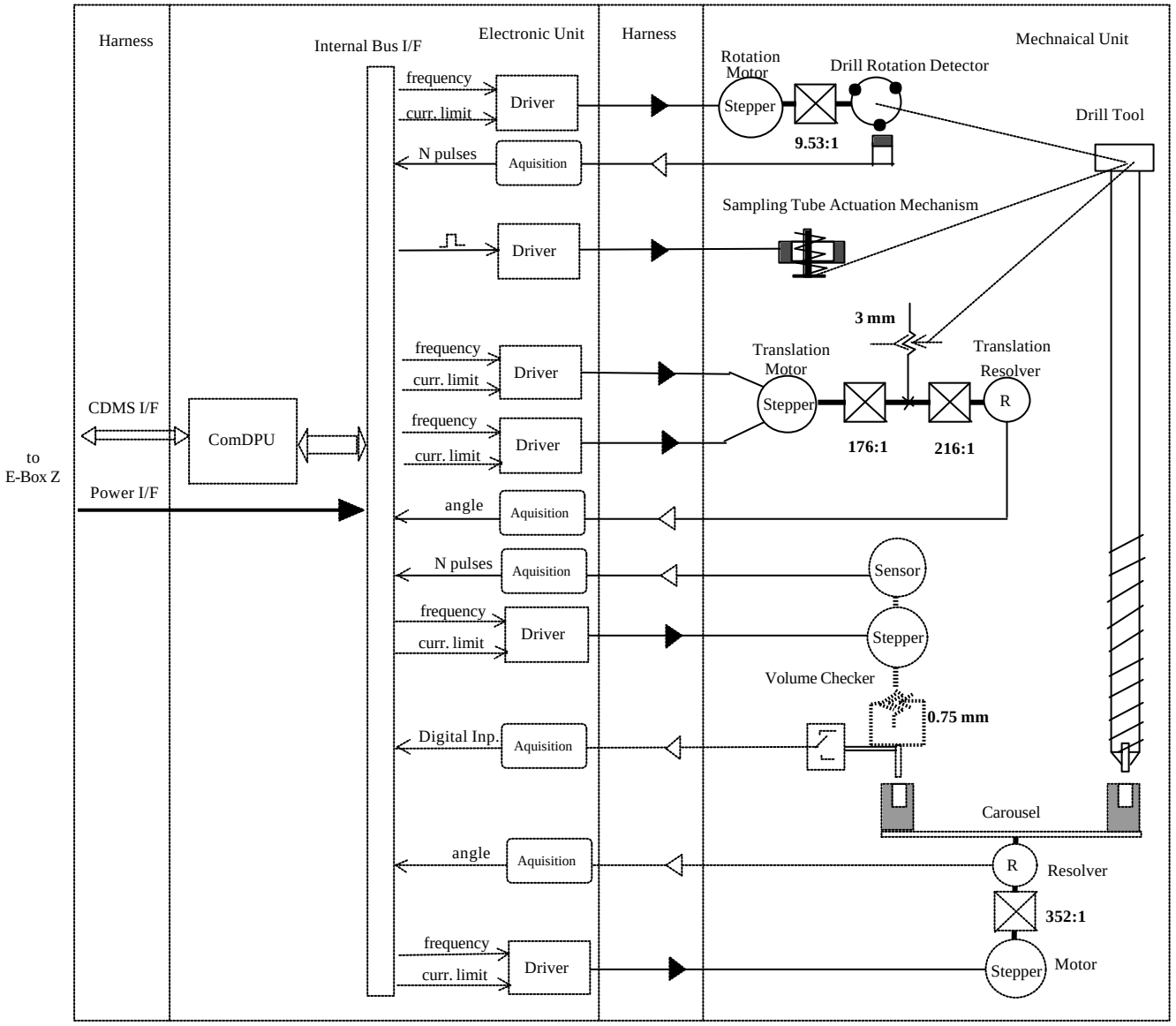


Figure 1.2-2 SD2 Functional Diagram

2. FUNCTIONAL REQUIREMENTS

2.1 SD2 SUBSYSTEM FUNCTIONAL REQUIREMENTS

1. The SD2 Subsystem shall be able to perform carousel rotation to a specified position
2. The SD2 Subsystem shall be able to move a specified oven towards a specified scientific port
3. The SD2 Subsystem shall be able to perform drill translation to a specified position
4. The SD2 Subsystem shall be able to perform drill rotation for a defined time
5. The SD2 Subsystem shall be able to perform drill translation and drill rotation together. Drilling capabilities shall be demonstrated.
6. The SD2 Subsystem shall be able to move volume checker and to measure the position of the central part of the Volume Checker tip.
7. The SD2 Subsystem shall be able to release and rearm the sampling tube
8. The SD2 Subsystem shall manage the telemetry data acquisition and dumping
9. The SD2 Subsystem shall be able to force all the movements to immediate/soft stop and to force all the devices to power off: emergency-stop/ halt commands
10. After execution of emergency-stop, SD2 shall enter in emergency status and shall wait for the end-of-emergency command to exit from emergency status and continue the command processing

    Note that the emergency-stop and the end-of-emergency are not tele-commands to be used during the nominal ROSETTA mission: they will be sent probably from EARTH
11. When a device (drill rotation, drill translation, volume checker, carousel, sampling tube) is commanded, only the electronics necessary for the motion control of the selected device shall be powered on. When the motion is completed, the electronics relevant to the selected device shall be powered off.
12. When SD2 Subsystem is powered on, all the devices of the mechanical units shall be powered off
13. Redundant driver for drill translation shall be provided; it will be used in automatic way by SD2 Subsystem as recovery driver when a failure in the main driver will be detected. See below section for further details. Drill translation shall be nominally performed by using the main driver.
14. SD2 Subsystem shall provide tele-command for checking the main and redundant drivers.
    Note: This tele-command should be issued before starting a drilling operation. If the check will fail, SD2 Subsystem will go into emergency status. At ROSETTA mission level it will be decide how to continue the mission (change the SD2 mission, or to execute it only when all the other Lander experiments have been completed,..).
15. The SD2 Mechanical Unit shall incorporate a set of Medium Temperature Ovens (MTO) that shall allow:
    - inspection of deposited samples with optical instruments CIVA-M and then
    - chemical analysis via interface to Tapping Station with sealing and heating actions.
16. The SD2 Mechanical Unit shall comply with CIVA-M and Tapping Station scientific interfaces.

2.2 SD2 SUBSYSTEM CHECKS

1. Before starting a movement, SD2 shall check that there are no interferences between the commanded device and all the SD2 mechanical parts:
   - the carousel motion is possible only if there are no interferences with the volume checker and the drill translation
   - the volume checker down motion is possible only if under its axis there is either an oven or the carousel hole
   - if the carousel hole is under the drill axis, then there are no constraint on drill translation motion; if an oven is under its axis, then it shall be rejected any translation command requiring to go through the oven base; if the re-arm oven is under its axis, then it shall be rejected any translation command requiring to go through the re-arm oven base; in any other case, it is possible only a translation motion until the oven top
   - the sampling tube can be released only if the carousel hole is under the drill axis or when the drill translation is all up
   - the drill rotation can start only if the carousel hole is under the drill axis
2. Before starting a movement, SD2 shall check if there are no interference between the commanded device and the other Lander units:
   - the carousel motion is possible only if the COSAC and PTOLEMY tapping stations are disengaged
   - the drill translation under the Lander Balcony is possible only if there is no interference with the Lander legs
3. When a motion is commanded (either drill rotation, or drill translation, carousel motion, volume checker motion), SD2 shall start a periodic check in order to detect failure in the motion of the device currently commanded

2.3 SD2 SUBSYSTEM AUTOMATIC RECOVERY ACTIONS

When a check fails, SD2 will notify it as telemetry data and will execute an automatic recovery procedure. According to a slave concept of SD2 subsystem and to its possible critic operations, there are only two automatic recovery actions performed by SD2:

- the recovery action related to drill translation check failure: see below item 2
- the recovery action to be applied to all the other failures; it consists of automatic execution of the emergency-stop/ halt procedure, which require an end-of-emergency command sent probably from EARTH to continue the processing

1. When a check fails, SD2 shall notify it to CDMS as telemetry data.
2. Automatic recovery procedure for the drill translation motion check failure:
   - if during a drill translation motion the periodic drill translation motion check fails, then SD2 shall continue the motion by using the main drill translation driver and a recovery torque value (instead of the torque specified in the motion command)
   - if the check fails again, then the motion shall continue with the recovery torque value and by using both the main and the redundant drivers
   - if the check fails again, then apply next recovery procedure (item 3 of current paragraph)
3. Automatic recovery procedure for all the other check failures:
   - If a check different from drill translation check fails, the SD2 shall start automatic execution of emergency-stop/halt procedure and to enter into emergency status

   Note: to exit from emergency, it is required the end-of-emergency command
4. It shall be possible to disable/ enable the recovery procedure relevant to unexpected status of COSAC/ PTOLEMY/ LANDG
5. When a check fails and the relevant recovery procedure is disabled, the execution of the command shall continue as the check was not failed
6. A test procedure shall be executed in order to identify the nominal values of speed and current of all the devices and the drill translation recovery torque value

2.4 COMET MATERIAL SAMPLING REQUIREMENTS

2.4.1 Comet Soil Characteristics

The SD2 Subsystem shall demonstrate its functions with the following soil materials.

	Characteristics		
Material	Compressive Strength	Porosity	Density
Fluffy stuff	< 1 Mpa with very low cohesion	50 - 70 %	< 500 kg/m^3
Gas concrete	1-3 MPa	50 - 70 %	1000 - 1500 kg/m^3

2.4.2 Sample Quantity

The volume of acquired sample before volume checker compressive action shall be in the range from 6 to 34 mm^3.

2.4.3 Sampling Depth

2.4.3.1 Maximum Sampling Depth

Assuming a clearance between Lander Balcony and comet surface equal to 300 mm the maximum sampling depth shall be above 230 mm.

2.4.3.2 Depth Selection

It shall be possible to collect samples at selectable different depths (up to the Maximum Depth).

2.4.4 Drill Misalignment

It shall be possible to demonstrate the ability to perform drilling/sampling while the angle between the drill direction and the local surface perpendicular is less than 5 degrees.

2.4.5 Sample Volume Measurement

The accuracy of linear distance measurement (associated to the sample volume measurement inside the ovens) shall be better than 5%.

2.4.6 Induced Loads

The loads from SD2 to the Lander during drilling/sampling operations shall not exceed the following limits:

- 10N while drilling the Gas Beton material at -50° (with compressive strength about 2 MPa) and
- 13N while drilling the Gas Beton material at -150° (compressive strength of about 3 MPa).

Note: fulfillment of this requirement will also garantee that torque load to Lander does not exceed 5 Nm on any axis (based on Lander/SD2 geometrics and drill misalignement limits).

2.4.7 Thermal Contamination

SD2 drilling operation shall not lead to sample material temperature increase for more than 5 °C.

3. STRUCTURAL/MECHANICAL SPECIFICATIONS

3.1 UNIT REFERENCE FRAMES

The URF of the Mechanical Unit shall coincide with the center of one of mounting holes at the bottom of the Base Plate.

The URF of the Electronic Unit coincides with the center of one of mounting holes at the bottom plate.

3.2 INTERFACE CONTROL DRAWINGS

3.2.1 Mechanical Unit ICD drawing

The drawing AD4 supports this specification.

The following data shall be indicated in the ICD drawing:

1. URF
2. Unit mounting interface
3. Unit envelope dimensions in stowed (launch) configuration;
4. Drill working stroke.
5. Center of Gravity position in stowed (launch) and extended (full drill length) configurations;
6. Momentums of Inertia w.r.t GoG in stowed and extended configurations;
7. Thermal interface data (surface optical properties, heat flux, conductive contact surface).
8. Electrical connectors type and position.

3.2.2 Electronic Unit ICD drawing

The drawing AD5 supports this specification.

The following data shall be indicated in the ICD drawing:

1. URF
2. Unit mounting interface;
3. Unit envelope;
4. Center of Gravity position;
5. Momentums of Inertia w.r.t CoG;
6. Thermal interface data (surface optical properties, heat flux, conductive contact surface).
7. Electrical connectors type and position.

3.3 MECHANICAL UNIT INTERFACES

3.3.1 Lander I/F

3.3.1.1 Unit Envelope

The unit envelope dimension shall be in line with AD4.

3.3.1.2 Fixation Points

3.3.1.2.1 Base Plate Fixation

The Base Plate shall provide 5 holes (for mounting screws) in conformance with the AD4.

3.3.1.2.2 Tool Box Fixation

The unit shall provide 8 M3 threads for two brackets (not part of SD2) with final clips to be secured to the structure as shown in fig. 2.3.1.2.2-1 are foreseen.

Position of threads is defined in AD4.

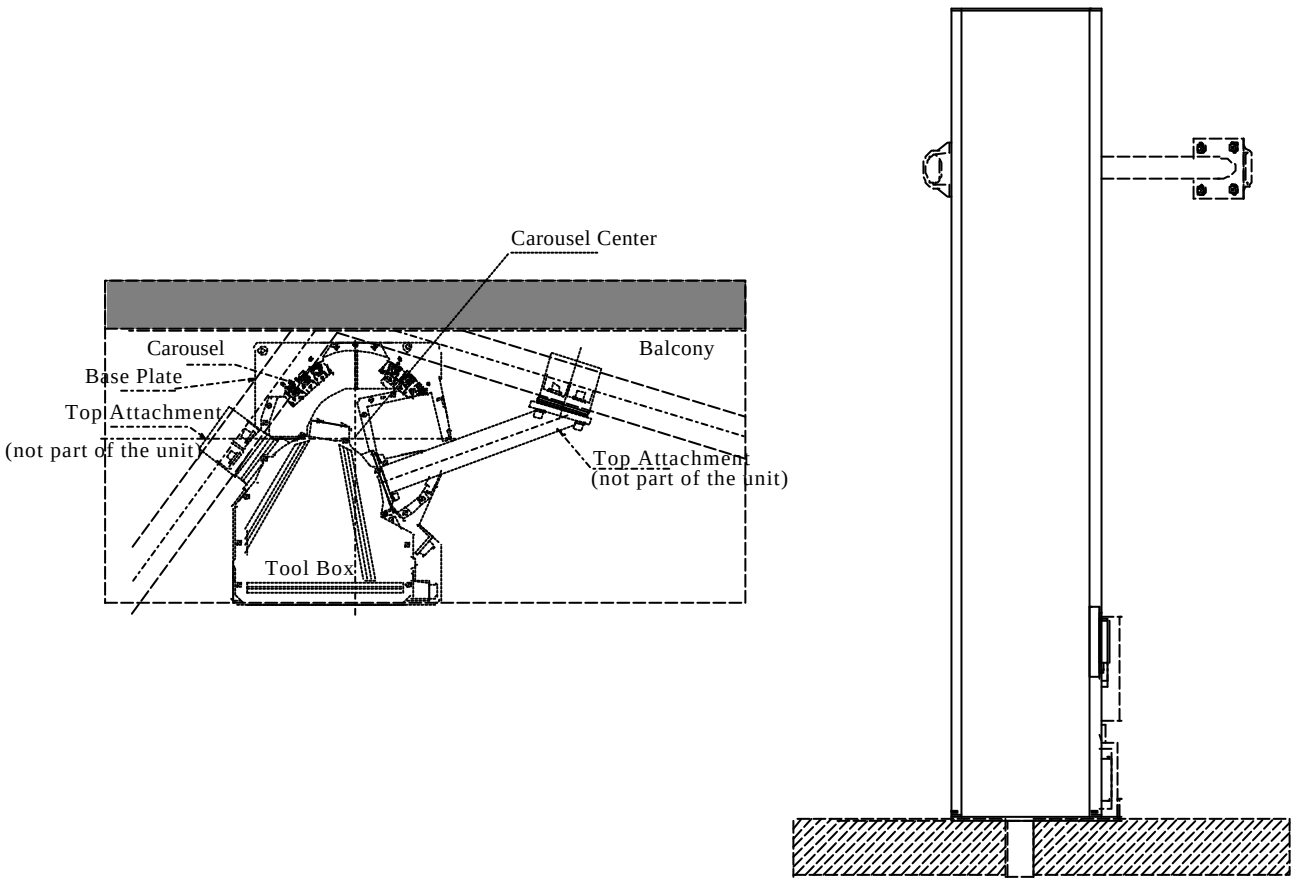


Figure 2.3.1.2.2-1 Tool Box top attachments

3.3.1.3 Drilling Hole

The SD2 Mechanical Unit shall be able to operate with drilling hole in the Lander Balcony position and diameter as shown in the figure 2.3.1.3-1.

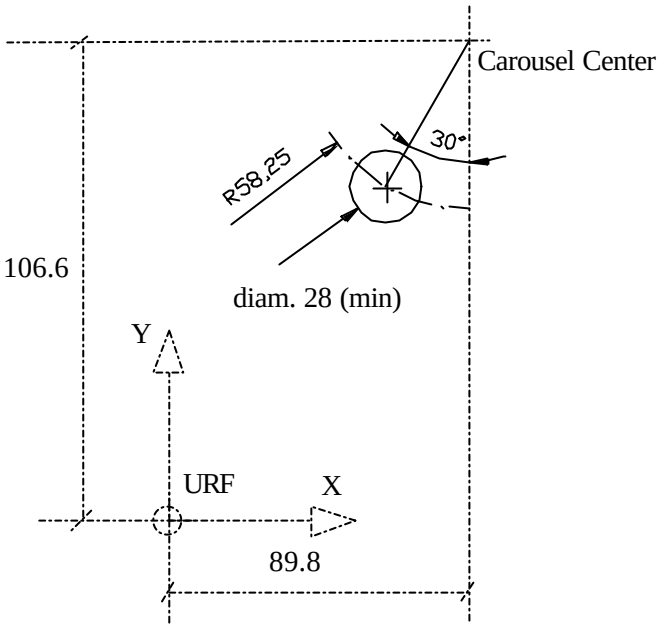


Figure 2.3.1.3-1 Drilling Hole

3.3.2 Çiva-M I/F

3.3.2.1 Optical

1. The Medium Temperature Ovens of the Mechanical Unit shall provide optical path for microscope inspection of the material inside as shown in the figure 2.3.2.1-1.
2. The prism main dimensions shall be as defined in figure 2.3.2.1-2.
3. The distances between the prism entrance plane and both the planes of the 2 Çiva-M mounting holes shall be $A_{02} \pm 0.1$mm (for Çiva-2) and $A_{03} \pm 0.1$mm (for Çiva-3). The reference (central) values A_{02} and A_{03} shall not be necessarily equal, but both of them shall be included in the 7.15 to 7.35 mm range.
4. Angular deviation of the prism from its theoretical position w.r.t. Mechanical Unit Base Plate shall be less than 40 arcmin for each axis as shown in figure 2.3.2.1-1.

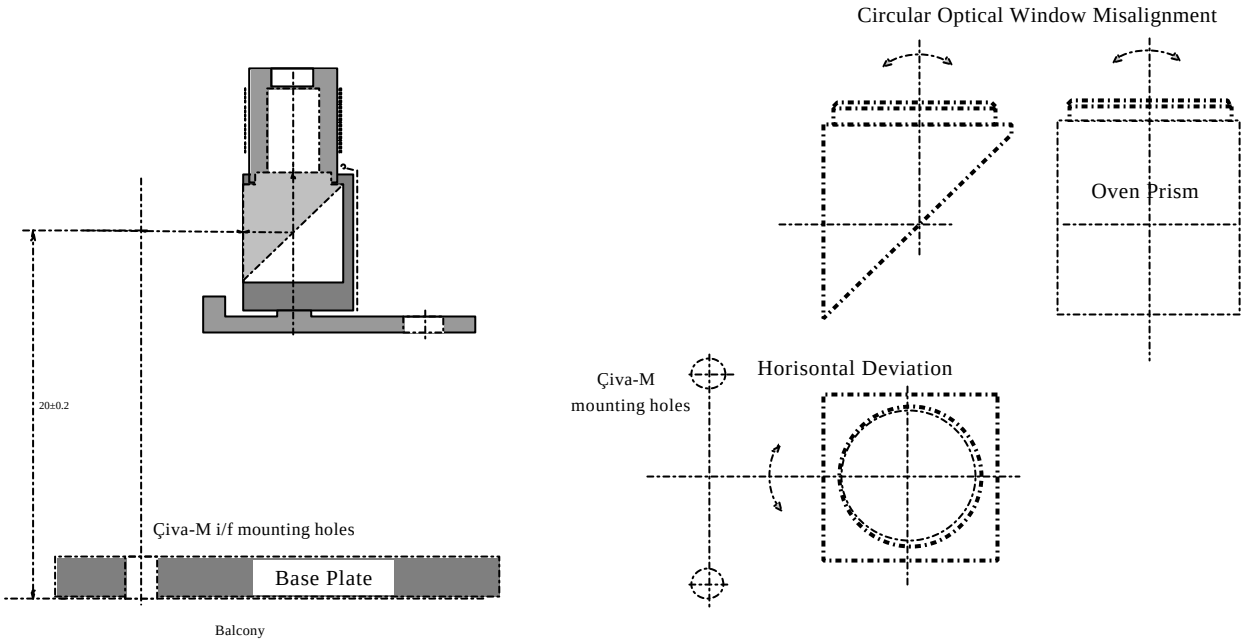


figure 2.3.2.1-1 Çiva-M optical interface

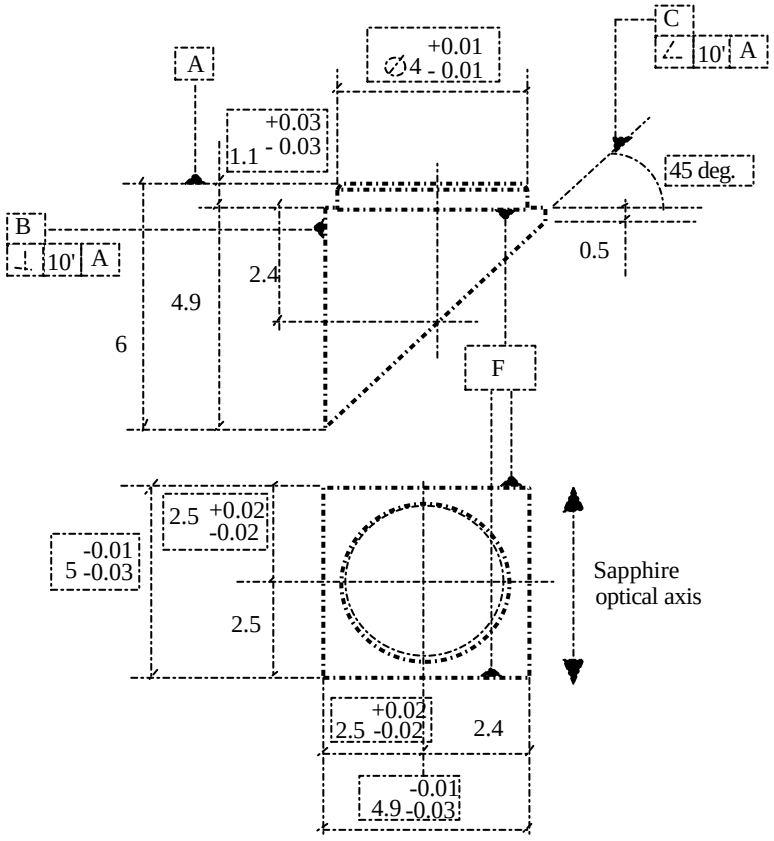


Figure 2.3.2.1-2 Sapphire Prism Dimensions

3.3.2.2 Mechanical

The Mechanical Unit shall provide two positions for Çiva-M instruments.

Two interface mounting holes ∅2 H7 for each position will be provided for reference pins ∅2 (to be provided by Çiva-M team).

The relative positions between Carousel Axis and Çiva-M interface mounting holes shall be as defined in AD4.

3.3.3 Tapping Station I/F

3.3.3.1 Mounting

The Mechanical Unit shall provide mounting positions for two Tapping Stations at the Base Plate.

For each station two holes ∅1 H8 for reference pins ∅1 mm (to be provided by COSAC/MODULUS team) and two threaded holes M2.5 are foreseen.

The relative positions between Carousel Axis and Tapping station mounting holes shall conform to AD4.

3.3.3.2 MTO Position

Medium Temperature Oven position w.r.t Carousel Axis shall conform to the AD4.

3.3.3.3 MTO Electrical Contacts

MTO shall provide 4 electrical contacts for Tapping Station:

- 2 for Heating Coil and 2 for Temperature Sensor

Dimensions and position of Electrical contacts is defined in AD4.

3.3.3.4 MTO Electrical Specification

The **Heating Coil** of the oven shall have the following properties:

- Wire material: Pt;
- Resistance: 9.5 ±20% Ω (at 25 °C)

The **Temperature Sensor** type shall be: Chromel-Alumel thermocouple type K;

3.3.3.5 MTO Heating Temperature

The MTO shall ensure heating temperature of +180...200 °C (with Heating Coil specified in section 3.3.3.4).

3.3.4 High Temperature Oven I/F

The SD2 shall provide on the Carousel mounting positions for 16 High Temperature Ovens (with envelopes not exceeding MTO dimensions).

High Temperature Ovens will be mounted on the Carousel disk through M2 screw in the same way as MTOs (as shown in AD4).

3.3.5 Carousel Position Accuracy

The angular positioning of the Carousel shall be performed with accuracy of ± 5 arcmin (w.r.t desired position).

3.3.6 Actuators Working Points

The actuators operational current working points shall be defined by applying a factor of at least 1.5 to the minimum current working points (the minimum currents that ensures mechanism movement at specified speed).

Operational actuator speed working points shall be defined based on:

1. Drill Translation:
   the drill tool speed shall ensure that the reaction force will not exceed
   - 10N while drilling the Gas Beton material at -50° and
   - 13N while drilling the Gas Beton material at -150°.
2. Drill Rotation, Carousel, Volume Checker:
   the value that ensures best reliability of mechanism function in specified environment.
3. Sampling Tube Mechanism shall ensure that reaction force during sample discharge action will not exceed:
   - 10N with the Gas Beton material at -50° and
   - 13N with the Gas Beton material at -150°.

3.4 MECHANICAL UNIT FIRST EIGENFREQUENCY

The first eigenfrequency of the Mechanical Unit shall be above 75 Hz.

3.5 APERTURE COVERS

The SD2 shall not contain aperture covers (parts to be removed after integration to Lander prior launch).

3.6 ELECTRONIC UNIT INTERFACES

3.6.1 Lander I/F

Electronic Unit mechanical interface to Lander shall conform to AD5.

3.6.2 First Eigenfrequency

The first eigenfrequency of the Electronic Unit shall be above 150 Hz.

3.7 MASS/INERTIA PROPERTIES

3.7.1 Mass

The mass of SD2 elements shall not not exceed limits defined in the table 3.7.1-1.

SD2 element	Mass (g) (max. limit of ICD)
Mechanical Unit (mass of High Temperature Ovens is not included)	3860 +2.5%
Electronic Unit	1020 +2.5%
Harness	525 + 2.5%

Table 3.7.1-1 SD2 units mass.

3.7.2 Centre of Gravity

3.7.2.1 Mechanical Unit

The Mechanical Unit CoG in Stowed and Extended configurations shall conform to the AD4.

3.7.2.2 Electronic Unit

The Electronic Unit CoG shall conform to the AD5.

3.7.3 Momentum of Inertia

3.7.3.1 Mechanical Unit

The MoIs of the Mechanical Unit w.r.t the unit's CoG in Stowed and Extended configurations shall conform to the AD4.

3.7.3.2 Electronic Unit

The MoIs of the Electronic Unit w.r.t the unit's CoG shall conform to the AD5.

4. ELECTRICAL SPECIFICATIONS

4.1 POWER SUPPLY INTERFACE

The subsystem can utilize the following power supplies from Lander Power Subsystem:

1. Primary Bus Power Line: P+28V;
2. Secondary Bus Power Lines:
   +5V,
   -5V,
   +12V,
   -12V.

All Power Lines have common return line.

4.1.1 Voltages

1. The subsystem shall be designed to operate with the following power line voltages:

Power Line	Nominal Range, V	Minimum Voltage, V	Maximum Voltage, V
P+28V	+ (21 - 30) V	+19	+30.4
+5V	+ 5.2 V +2/-3%	+ 4.0	+ 5.5
-5V	- 5.0 V +2/-3%	- 4.0	- 5.5
+12V	+ 12 V +2/-3%	+ 9.6	+ 13.2
-12V	- 12 V +2/-3%	- 9.6	- 13.2

2. The subsystem shall ensure its functional performances while power supply voltages are within Nominal Range.
3. The subsystem shall survive any constant or fluctuating voltages in the full range of Minimum to Maximum Voltages defined.
4. The subsystem shall survive the drop-out of any voltage line for 1 s and tolerate a complete power down in any phase of activity.
5. The subsystem shall survive an unbalanced powering (i.e. only +5/+12V or only P+28V or only -5/-12V) without performances degradation for infinite time.
6. The subsystem shall survive an instantaneous short circuit on any of the voltage lines.

4.1.2 Currents

4.1.2.1 Secondary Bus Currents

Current consumption on secondary power lines shall not exceed limits defined in the table (at all range of power line voltages and operational conditions):

Power Line	Maximum Current, mA
+5V	320
-5V	50
+12V	130
-12V	60

4.1.2.2 Primary Bus Current

The Current on P+28V power line shall be compatible with the current limiter implemented in Lander Power Distribution System on P+28V power line as specified in AD2 section 3.2.2. while the limiter nominal current **Inom.max** is set to 1.0 A.

4.1.2.3 Deleted

4.1.3 Power Consumption

The total power consumption from the power supplies (including 600 mW of Com-DPU power dissipation) shall not exceed specified limits for test cases defined in:
- the table 4.1.3-1 before completion of subsystem level tests with EQM that allow definition of operational working points according to section 3.3.6;
- the table 4.1.3-2 after definition of operational working points.

#	Case Name	Power Save and Driver Settings	Consumption (average), W	
			at nominal voltage (P+28V=28V) and 25°C	whole range of voltages/temperatures
0	Stand-by	all power save switches are OFF	< 1.5	< 1.5
1	Drilling	Drill Rotation Motor: phase current (RMS): at least 0.75 A, speed : 791 rpm; Drill Translation Motor: phase current (RMS): 0.25A, speed: 87.6 rpm; Drill Translation Resolver Acquisition is ON; All other power save switches are OFF	< 12.7	< 14.5
2	Sampling	Drive Sampling Tube Coil: continuous current; Drill Rotation Motor: current setting : 25% of Imax (0.5A), speed: 791 rpm; All other power save switches are OFF	< 12.7	< 14.5
3	Translation Sensor Acquisition	Drill Translation Resolver Acquisition is ON; All other power save switches are OFF	< 5.3	< 6.0
4	Carousel Rotation	Carousel Rotation Motor: current setting: 62.5% of Imax (0.375A), speed: 83 rpm; Carousel Resolver Acquisition is ON; All other power save switches are OFF	< 5.3	< 6.0

5	Volume Checker operation	Volume Checker Motor: current setting: 100% of I max (0.6 A), speed: 618 rpm; All other power save switches are OFF	< 5.3	< 6.0

Table 4.1.3-1: power consumption before working points definition

#	Case Name	Power Save and Driver Settings	Consumption (average), W	
			at nominal voltage (P+28V=28V) and 25°C	whole range of voltages/temperatures
0	Stand-by	all power save switches are OFF	< 1.5	< 1.5
1	Drilling	Drill Rotation Motor: phase current : Working Point, speed : Working Point ; Drill Translation Motor: phase current: Working Point, speed: Working Point; Drill Translation Resolver Acquisition is ON; All other power save switches are OFF	< 12.7	< 14.5
2	Sampling	Drive Sampling Tube Coil: continuous current; Drill Rotation Motor: phasee current / speed: Working Point for sampling scenarion (may be off); All other power save switches are OFF	< 12.7	< 14.5
3	Translation Sensor Acquisition	Drill Translation Resolver Acquisition is ON; All other power save switches are OFF	< 5.3	< 6.0
4	Carousel Rotation	Carousel Rotation Motor: phase current: Working Point, speed: Working Point; Carousel Resolver Acquisition is ON; All other power save switches are OFF	< 5.3	< 6.0
5	Volume Checker operation	Volume Checker Motor: phase current: Working Point, speed: Working Point; All other power save switches are OFF	< 5.3	< 6.0

Table 4.1.3-2: Power consumption for working points defined in section 3.3.6

4.1.4 Power Lines Insulation

Resistance measured between any of power lines pins at the subsystem External Connectors and unit's structure shall be above 1 Mohms in AIV ambient conditions.

4.2 DATA AND COMMAND INTERFACES

SD2 will interface to the Command and Data Managements System (CDMS).

Data interchange with CDMS occurs exclusively on word by word exchanging and is based on *Action Codes* and *Request Codes* (according to CDMS wording): SD2 will use the Action Codes and the Request Codes provided by CDMS in order to receive commands and to transmit its telemetry data. The telemetry data will consist of scientific data, housekeeping data and backup-Ram data. It is foreseen that nominally only a subset of Action Codes shoud be sent to SD2.

The data format and the communication protocol to CDMS are specified in [RD1].

SD2 will use the Common-DPU board used also by other Lander units to interface to CDMS.

4.2.1 SD2 CDMS I/F

SD2 shall interface to the CDMS according to the communication protocol specified in [RD1], sections "3.3.2.3 Selection of CIU main/redundant", "3.3.3 Word and Message Formats", "3.3.5 CDMS Services"

4.2.2 CDMS actions and request codes

1. SD2 shall be able to receive telecommand and to send telemetry data by using the Action Codes and the Request Codes marked as “Y” in tables 4.2.2-1 and 4.2.2-2.
2. If an Action Code marked as “N” is received, SD2 shall react according to [AD9].
3. SD2 shall be able to notify CDMS that an operation is completed by using the “OCPL” Request Code according to [AD10]

Mnemo	*Implemented by SD2*	*Action Code*
TRSW	Y (*)	Transmit Status Word
TRQC	Y	Transmit Request Code Word
STBY	N	Standby Mode/Power Down
RMOD	N	Receive Current CDMS Mode
RTIM	Y	Receive On-Board Time
RSST	N	Receive Service System Status
RAXT	N	Receive Action Code/Subaddress Extension
RHFM	Y	Receive Housekeeping Data Format Count
THKD	Y	Transmit Housekeeping Data Word
RCMD	Y	Receive Telecommand Sequence
TCMO	Y	Transmit Offset/Length of Stored Telecommand Buffer Section
RCMS	Y	Receive Stored Telecommand Buffer Section
RASV	N	Receive Allocated Science Data Volume
TSCR	Y	Transmit Science Data Burst
RSCS	N	Receive Science Data Packet Checksum
RBUS	N	Receive Allocated Backup RAM Buffer Size
TBUP	Y	Transmit Pointer of Backup RAM Buffer Record
TBUF	Y	Transmit Backup RAM Buffer Record
RBUF	Y	Receive Backup RAM Buffer Record
TTRG	N	Transmit Trigger Word
RTRG	N	Receive Trigger Word
RERC	N	Receive Error Code Word

(*) It is implemented via hardware

Table 4.2.2-1 Action Code List

Mnemo	*Used by SD2*	*Request Code*
SSST	N	Send Service System Status
SCMD	Y	Send Stored Telecommand Buffer Section
SASV	N	Send Allocated Science Data Volume
SRDY	Y	Science data Ready
SBUS	N	Send Allocated Backup RAM Buffer Size
WRBF	Y	Write Backup RAM Buffer Size
RDBF	Y	Read Backup RAM Buffer Size
STRG	N	Pass trigger Word
FLSP	Y	Flush Last Science Data Packet
OCPL	Y	Operation Completed

Table 4.2.2-2 Valid *Request Code* List

4.2.3 SD2 specific commands

1. DELETED
2. Specific commands shall be specified in "SD2-CDMS ICD" document. When a specific command is received, SD2 shall check that the command syntax is according to the "SD2-CDMS ICD" document.
3. The list of specific commands shall contain commands allowing respectively:
   - to perform carousel rotation to a specified position
   - to move a specified oven towards a specified scientific port
   - to perform drill rotation to a specified position
   - to perform drill rotation for a defined time
   - to move volume checker and to measure the collected materials
   - to release and rearm the sampling tube
   - to manage the scientific data acquisition and dumping
   - to load a sequence of SD2 specific commands stored into CDMS
   - to retrieve the forbidden ranges of Landing Gear
   - to force all the movements to stop and to force all devices to power off: emergency-stop command
   - to enable/disable the recovery actions related to a failure class
   - to go out the emergency status: end-of-emergency command
   - to notify CDMS that the specified operation (drilling, sampling, carousel movement) is completed
4. SD2 specific commands shall be executed sequentially, each specific command is processed when the execution of previous one is successfully completed. Drill rotation is successfully completed when the commanded coasting speed has been reached
5. Exception to the specific command sequence execution shall be provided to the execution of the emergency stop command: the emergency-stop shall be executed when received and shall remove the sequence of pending specific commands.

   Note that the emergency-stop is not a specific command to be used during a nominal mission, but it is usefull during the SD2 development, and could be sent from EARTH when something is wrong.
6. SD2 shall avoid deadlock in the communication to CDMS every time SD2 raises a request to CDMS
7. It shall be possible to disable/ enable the recovery procedure relevant to the following CDMS communication errors:
   - action code not foreseen
   - problems during backup ram writing/reading
   - errors raised during a SD2 request to CDMS

4.2.4 SD2 telemetry data

1. SD2 shall provide as telemetry data:
   - scientific data
   - housekeeping data
   - backup RAM data

   and they shall be specified in the "SD2-CDMS ICD" document

2. SD2 shall measure 4 analog housekeeping signals (voltage in the range ± 3 V) coming from Lander Power Distribution System (Housekeeping Signals) and send the measured data to CDMS as housekeeping data:

Housekeeping Signal
HK-I (5V)
HK-I (-5V)
HK-I (12V)
HK-I (-12V)

1. Contents of SD2 backup RAM shall be according to [AD10]

4.3 POWER AND ENERGY BUDGETS

The table 4.3-1 shows the detailed SD2 subsystem power and energy budget per mission phases.

MISSION PHASE		SUBSYSTEM OPERATION		RESOURCES AVAILABLE for the CURRENT OPERATION	
Definition	**Duration**	**Definition**	Accumulated Operation Duration(sec)	Pw W	Energy Wh
Commissioning	90 days	Subsystem test and maintenance	1200	6	2
Cruise Hibernation Activated	About 8years	Main Power (28V bus) OFF. Possibility to perform SD2 S/S SW upload (by safely powering only secondary line) under ROSETTA system level responsibility. Total cumulative value are given for five checks assumed (one at each flyby)	2000	6	3,4
Comet RDV Manoeuvre	113 days	Main Power (28V bus) OFF. Possibility to perform SD2 S/S SW upload (by safely powering only secondary line) under ROSETTA system level responsibility.	400	6	0,7
Comet drift phase	263days	Main Power (28V bus) OFF. Possibility to perform SD2 S/S SW upload (by safely powering only secondary line) under ROSETTA system level responsibility.	400	6	0,7
Comet approach navigation and manoeuvring	90days	Main Power (28V bus) OFF. Possibility to perform SD2 S/S SW upload (by safely powering only secondary line) under ROSETTA system level responsibility.	400	6	0,7
Nucleus mapping and close observation	60 days	Main Power (28V bus) OFF. Possibility to perform SD2 S/S SW upload (by safely powering only secondary line) under ROSETTA system level responsibility.	400	6	0,7
Delivery preparations	7 days	off			0
Lander separation and descent	<6 hours TBC	off			0
First scientific sequence/Relay-phase operations	First 60h	In the first 60hours 4 samples acquisition are performed: 2 samples acquisitions (one surface and one subsurface) per 2 different kind of ovens (microscope/medium temperature and high temperature). Total resources (only for specific SD2 operation) for worst case assuming to drill material defined in para 2.4.1. In this first 60 hours a total SD2 operative time of 17 hours is expected (see detailed below).			
		Surface sample acquisition for distribution to microscope /medium temperature (+180°) experiment.	10500 + 4000	14.5 6.0	49
		Sub-surface sample acquisition (depth ca 230mm) for distribution to microscope /medium temperature (+180°) experiment.	7400 + 8500	14.5 6.0	44
		Surface sample acquisition for distribution to high temperature (+800°) experiment.	10500 + 4000	14.5 6.0	49
		Sub-surface sample acquisition (depth ca 230mm) for distribution to high temperature (+800°) experiment.	7400 + 8500	14.5 6.0	44
First scientific sequence/Relay-phase operations	Second 60h	In the second 60hours 4 samples acquisition can be forseen: 2 samples acquisitions (one surface and one subsurface) per 2 different kind of ovens (microscope/medium temperature and high temperature). Total resources (only for specific SD2 operation) for worst case assuming to drill material defined in para 2.4.1. In this first 60 hours a total SD2 operative time of 17 hours is expected (see detailed below).			
		Surface sample acquisition for distribution to microscope /medium temperature (+180°) experiment.	10500 + 4000	14.5 6.0	49
		Sub-surface sample acquisition (depth ca 230mm) for distribution to microscope /medium temperature (+180°) experiment.	7400 + 8500	14.5 6.0	44
		Surface sample acquisition for distribution to high temperature (+800°) experiment.	10500 + 4000	14.5 6.0	49

		Sub-surface sample acquisition (depth ca 230mm) for distribution to high temperature (+800°) experiment.	7400 + 8500	14.5 6.0	44
Extended mission	TBD days	off			0

Table 4.3-1: Power Consumption and Energy budget per mission phases.

4.4 CONNECTORS AND HARNESS DEFINITION

4.4.1 Connectors

4.4.1.1 Electronic Unit Connectors

Electronic Unit connectors type and position shall conform to AD5.

4.4.1.2 Mechanical Unit Connectors

Mechanical Unit connectors type and position shall conform to AD4.

4.4.1.3 E-box Interface Connector

SD2 interface connector to E-box P168 shall be of MDM 31S type.
Connector pins assignment shall be as defined in the table.

pin #	function
1	+5V
2	-5V
3	shield
4	+12V
5	-12V
6	shield
7	CLK_main
8	0V_main
9	shield
10	CMD_main
11	DATA_main
12	HK-I (12V)
13	HK-P
14	HK-I (5V)
15	HK-I (-5V)
16	shield
17	+28V
18	common power return
19	shield
20	+28V_red
21	common power return
22	shield
23	CLK_red
24	OV_red
25	shield
26	CMD_red
27	DATA_red
28	HK-I (28V)
29	HK-I (-12V)
30	shield
31	shield

4.4.2 Harness

SD2 Harness will consist of two cables:

- cable 1: interconnection cable between SD2 Electronic Unit and Mechanical Unit.
- cable 2: to interface Lander CDMS and Power System via E-box.

SD2 Harness drawings are provided in RD2 and RD3.

5. ENVIRONMENTAL SPECIFICATIONS

5.1 THERMAL

5.1.1 Temperature Range

SD2 shall be designed for the temperature range of surrounding environment (radiative and conductive) guaranteed by Lander Thermal Control System as defined in table 5.1.1-1.

		Environment Temperature Range
Electronic Unit	operational	-40 to +50 °C
	non-ops	-55 to +70 °C
Mechanical Unit	operational	-140 to -50 °C
	non-ops	-150 to 0 °C
Harness	warm compartment	-40 °C to + 50 °C.
	balcony	-140 °C to - 50 °C

Table 5.1.1-1: SD2 environment temperature range.

5.1.2 Thermal Control Concept

Only passive thermal control is allowed (radiative + conductive).

5.2 VIBRATIONS

Vibrations Environment is specified as test levels for SD2 units.
The levels are given for Lander URF axes.

Table 5.2-1: Directions of unit URFs (mounted at the Lander) w.r.t Lander URF

Lander URF axes	SD2 unit URF axes	
	Mechanical Unit	Electronic Unit
X	y	-x
Y	-x	y
Z	z	-z

5.2.1 Mechanical Unit

Vibration Test levels for Mechanical Unit are specified for base plate and top of the unit.

Sine Vibrations

Table 5.2.1-1: Sine Vibrations test levels for Mechanical Unit base plate

Lander axis	Frequency, Hz	Qualification		Acceptance	
		Input Level	Sweep Rate	Input Level	Sweep Rate
X	5 - 20	± 7.5 mm	2 oct/min	± 5 mm	4 oct/min
	20 - 25	12 g		8 g	
	25 - 55	10 g		6.7 g	
	55 - 75	9 g		6 g	
	75 - 85	linear interpolation		linear interpolation	
	85 - 100	3 g		2 g	
Y	5 - 20	± 7.5 mm		± 5 mm	
	20 - 25	12 g		8 g	
	25 - 55	10 g		6.7 g	
	55 - 75	8 g		5.3 g	
	75 - 85	linear interpolation		linear interpolation	
	85 - 100	2 g		1.3 g	
Z	5 - 20	± 7.5 mm		± 5 mm	
	20 - 25	12 g		8 g	
	25 - 55	10 g		6.7 g	
	55 - 75	8 g		5.3 g	
	75 - 85	linear interpolation		linear interpolation	
	85 - 100	3 g		2 g	

for unit axis definition refer to table 5.2-1.

Table 5.2.1-2: Sine Vibrations test levels for Mechanical Unit top

Lander axis	Frequency, Hz	Qualification		Acceptance	
		Input Level	Sweep Rate	Input Level	Sweep Rate
X, Y	5 - 16 16 - 21 21 - 70 70 - 80 80 - 85 85 - 100	± 12.1 mm 12.5 g 15 g 20 g linear interpolation 10 g	2 oct/min	± 8.1 mm 8.3 g 10 g 13.3 g linear interpolation 6.7 g	4 oct/min
Z	5 - 17 17 - 55 55 - 80 80 - 85 85 - 100	± 11.6 mm 13.5 g 9 g linear interpolation 4 g		± 7.7 mm 9 g 6 g linear interpolation 2.7 g	

for unit axis definition refer to table 5.2-1

Random Vibrations

Table 5.2.1-3: Random Vibration test levels for Mechanical Unit baseplate

Lander axis	Frequency, Hz	Qualification		Acceptance	
		Input Level	Duration	Input Level	Duration
all Grms=4.82	20 - 100 100 - 200 200 - 2000	+ 6 dB/oct 0.1 g^2/Hz - 9 dB/oct	2.5 min (per axis)	+ 6 dB/oct 0.044 g^2/Hz - 9 dB/oct	1 min (per axis)

for unit axis definition refer to table 5.2-1

Table 5.2.1-4: Random Vibration test levels for Mechanical Unit top

Lander axis	Frequency, Hz	Qualification		Acceptance	
		Input Level	Duration	Input Level	Duration
X Grms=8.67	20 - 90 90 90 - 200 200 - 300 300 - 2000	+ 6 dB/oct 0.5 g^2/Hz - 6.1 dB/oct 0.1 g^2/Hz - 6 dB/oct	2.5 min (per axis)	+ 6 dB/oct 0.22 g^2/Hz - 6.1 dB/oct 0.044 g^2/Hz - 6 dB/oct	1 min (per axis)
Y Grms=8.35	20 - 90 90 90 - 150 150 - 300 300 - 2000	+ 9 dB/oct 0.6 g^2/Hz - 10.6 dB/oct 0.1 g^2/Hz - 6 dB/oct		+ 9 dB/oct 0.264 g^2/Hz - 10.6 dB/oct 0.044 g^2/Hz - 6 dB/oct	
Z Grms=5.91	20 - 100 100 - 200 200 - 2000	+ 6 dB/oct 0.15 g^2/Hz - 9 dB/oct		+ 6 dB/oct 0.066 g^2/Hz - 9 dB/oct	

for unit axis definition refer to table 5.2-1

5.2.2 Electronic Unit

Sine Vibrations

Table 5.2.2-1: Sine Vibrations test levels for SD2 Electronic Unit

Lander axis	Frequency, Hz	Qualification		Acceptance	
		Input Level	Sweep Rate,	Input Level	Sweep Rate,
X	5 - 20 20 - 55 55 - 75 75 - 85 85 - 100	± 8.7 mm 14 g 9 g linear interpolation 3 g	2 oct/min	± 5.8 mm 9.3 g 6 g linear interpolation 2 g	4 oct/min
Y	5 - 20 20 - 55 55 - 75 75 - 85 85 - 100	± 9.3 mm 15 g 10 g linear interpolation 6 g		± 6.2 mm 10 g 6.7 g linear interpolation 4 g	
Z	5 - 20 20 - 55 55 - 75 75 - 85 85 - 100	± 9.3 mm 15 g 11 g linear interpolation 4 g		± 6.2 mm 10 g 6.7 g linear interpolation 4 g	

for unit axis definition refer to table 5.2-1

Random Vibrations

Table 5.2.2-2: Random Vibrations test levels for SD2 Electronic Unit

Lander axis	Frequency, Hz	Qualification		Acceptance	
		Input Level	Duration	Input Level	Duration
X Grms=7.54	20 - 100 100 - 200 200 - 2000	+ 10 dB/oct 0.3 g^2/Hz - 12 dB/oct	2.5 min	+ 10 dB/oct 0.133 g^2/Hz - 12 dB/oct	1 min
Y, Z Grms=8.71	20 - 100 100 - 200 200 - 2000	+ 10 dB/oct 0.4 g^2/Hz - 12 dB/oct	(per axis)	+ 10 dB/oct 0.177 g^2/Hz - 12 dB/oct	(per axis)

for unit axis definition refer to table 5.2-1

5.2.3 Harness

The cables of SD2 harness shall withstand vibration environment specified for the units to which the cables are connected.

5.3 RADIATION

The SD2 shall withstand without performances degradation the 15 Krad total radiation dose.

5.4 GROUND CONDITIONS

5.4.1 AIV Environment

The SD2 equipment shall allow AIV activities in the following conditions (excluding Mechanical Unit operations):

- Pressure: sea level;
- Humidity: 55% maximum;
- Temperature: 22°C ± 3°C.

Functional Testing of the Mechanical Unit (that contains MoS2 lubricated parts) shall be performed only in thermal vacuum environment in specified temperature range.

Testing of the Mechanical Unit during integration (if needed) shall be preferably performed in Nitrogene purgine environment.

In case more intensive testing of the unit is needed at integration and preliminary AIV finalisation phases (for EQM model) the refurbishment MOS2 lubricated parts (at least of components developed by Tecnospazio) shall be performed before formal Functional Tests.

5.4.2 Unprotected Environment

The SD2 equipment shall be provided with transport and storage means to allow its storage and transportation in the following environment:

- Pressure: sea level;
- Humidity: up to 95 %;
- Temperature: -50°C to +50°C;

5.5 EMC

5.5.1 Conducted Emissions

The subsystem shall comply with the following requirements defined in AD1:

AD1 section	Requirement	Application Remark
2.9.4.1.1.	Conducted Emissions, Primary Power Lines, Differential Mode	for P+28 V power line only
2.9.4.1.2.	DELETED	Not applicable since SD2/Lander interface foresees a common return for all power lines)
2.9.4.1.4.	Conducted Emissions Voltage Transients	for P+28 V power line only
2.9.4.1.5	Conducted Emissions, Secondary Bus	
2.9.4.1.6.	Conducted Emissions on signal and control lines, common mode	narrowband

5.5.2 Conducted Susceptibility

The subsystem shall comply with the following requirements defined in AD1:

AD1 section	Requirement	Application Remark
2.9.4.2.1.	Conducted Susceptibility, Primary Power	for P+28 V power line only
2.9.4.2.2.	Conducted Susceptibility, Primary Power, Transients	for P+28 V power line only
2.9.4.2.3	Conducted Susceptibility, secondary power lines, sinewave	
2.9.4.2.4	Conducted susceptibility on signal and control lines	

5.5.3 Radiated Emissions

The subsystem shall comply with the following requirements defined in AD1:

AD1 section	Requirement	Application Remark
2.9.4.3.1.	Electric Field Emission Limits	
2.9.4.3.2	Radiated emissions, AC magnetic field	

5.5.4 Radiated Susceptibility

The subsystem shall comply with the following requirements defined in AD1:

AD1 section	Requirement	Application Remark
2.9.4.4.1.	Electric Field Susceptibility	
2.9.4.4.2	Radiated Susceptibility, magnetic field, DC&AC	

5.5.5 Bonding

1. The resistance between unit's bonding stud and the unit case mounting surface shall be less than or equal to 2.5 mOhms.
2. Unit's external connector bodies shall be connected to unit's case with bonding resistance less than or equal to 10 mOhms.
3. The outer surfaces exposed to space shall be conductive.
   The DC resistance measured between two points of the surface shall be less than 10 Ohms.

5.5.6 Grounding Concept

No galvanic insulation between motor power drivers and control circuitry is foreseen.

The power lines shall be isolated from structure.

SD2 grounding concept shall be as shown in figure 5.5.6-1.

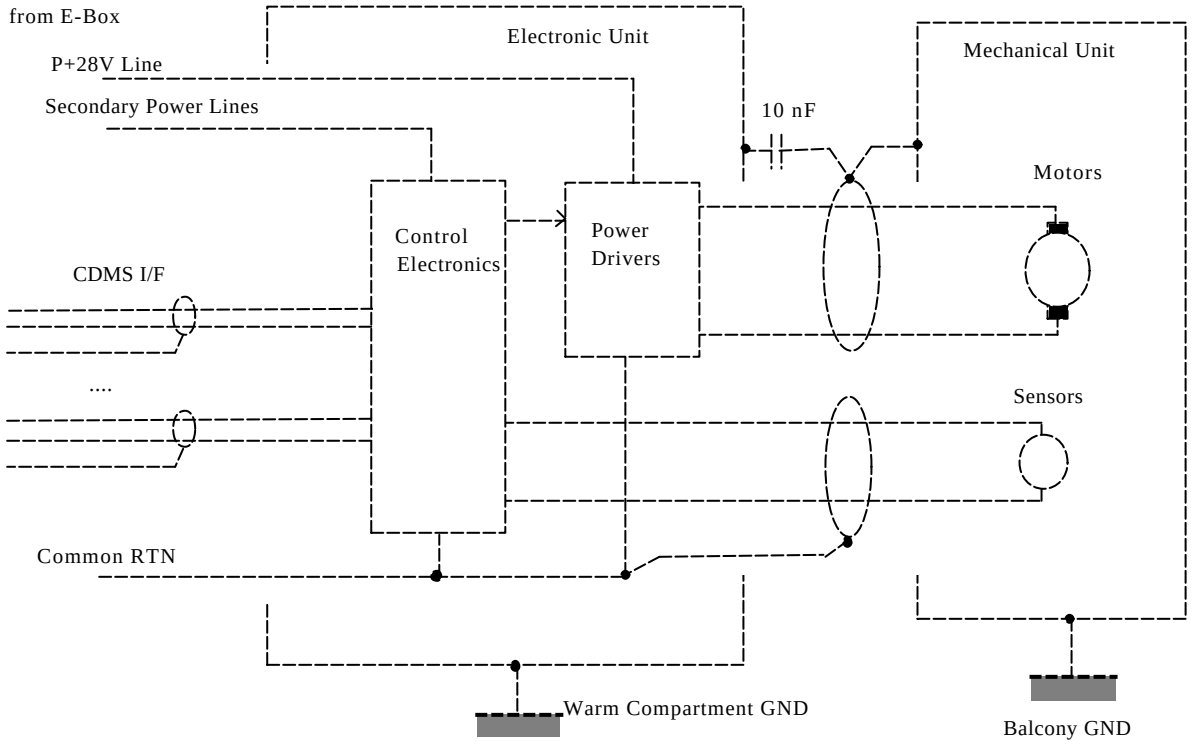


Figure 5.5.6-1 SD2 Grounding Concept

6. LIFE TIME

6.1 NOT OPERATIVE ON-GROUND

The SD2 (after acceptance) shall ensure its performances prior flight (integration and utilization on Lander Level) for at least 2 years, including:

- presence in Unprotected Environment (section 5.4.2) for no more than 10 days (TBC) in transport configuration (packed in transport containers).
- On-ground testing specified at next paragraph.

6.2 OPERATIVE ON-GROUND (TESTING)

The SD2 (after acceptance and delivery to Lander level) shall allow the following testing time in AIV environment:

Electronic Unit: at least 250 hours.

Mechanical Unit: at least 2 (TBC) cycles of Limited Functional Test procedure;
Note: mechanism movements during the test will be limited to allow health-check only.

Functional Testing of the Mechanical Unit involving mechanisms motion shall be performed in vacuum or Nitrogen purging environment.

6.3 CRUISE PHASE

The SD2 shall be designed to withstand cruise phase on-board Rosetta Lander for 9 years.

6.4 OPERATIVE ON COMET

1. The SD2 Electronic Unit shall be designed to perform operations in on-comet environment for 150 hours.
2. The SD2 Mechanical Unit shall be designed to perform at least 4 full drilling/sampling/discharge/rearming cycles in on-comet environment.
   Possibility to perform 8 full cycles shall be assessed.

7. QUALITY ASSURANCE

SD2 Product Assurance Plan is defined in AD7 that is in line with RO-LAN-PL-3201/jb 'Lander PA Plan'.

The AD7 specifies all PA/safety/reliability/configuration requirements (and their verification) applicable to SD2.

7.1 CLEANLINESS

Assembly, integration and testing shall be performed in cleanliness class 100.000 environment.

Medium Temperature Ovens shall be manufactured in cleanliness class 10.000 environment.

7.2 COMPONENTS AND MATERIALS

Selection and certification of components, materials and processes shall be performed in accordance with section 9.2 of AD7.

8. DESIGN VERIFICATION

8.1 MODELS PHILOSOPHY

SD2 models are defined in table 8.1-1.

Model type	Model main properties			
	Mechanical Unit	Electronic Unit	Software	Harness
STM	Static mechanical model representative of dimensions, mass, COG, structural stiffness, dissipation	Dummy model representative of dimensions, mass, COG, dissipation	NA	Dummy model
EM	Representative in dimensions, electrical schematics, electromechanical components of commercial type	Representative of FM except: - components (commercial), - environment (for on-ground use only - no vibrations and TV tests)	Prototype SW to allow EMC tests of Lander	NA
EQM	Representative of flight model	Representative of FM except: - hi-rad components	Engineering model SW (subset of FM)	Representative of flight model
FM	Flight model	Flight model	Flight model	Flight model
FS	Refurbishment of EQM	Equal to FM	Same software as per FM	NA

Table 8.1-1 SD2 models

The EQM model will be developed for SD2 verification purpose.

The STM models will be delivered for Lander structural/thermal design verification.

The EM models will be delivered for Lander Electrical Integration Verification and EMC testing.

8.2 VERIFICATION PLAN

The table8.2-1 defines application of requirements for SD2 models and methods for verification.
Legend:
* - applicable;
NA - not applicable.

Requirement	verification method	EQM	FM	FS	SW
2.1. SD2 Subsystem Functional Requirements	Functional Test	*	*	*	*
2.2. SD2 Subsystem Checks	Functional Test	*	*	*	*
2.3. SD2 Subsystem Automatic Recovery Actions	Functional Test	*	*	*	*
2.4.1. Comet Soil Characteristics		*	*	*	NA
2.4.2. Sample Quantity	Sampling Tests with EQM	*	*	*	NA
2.4.3. Sampling Depth	(section 7.3)	*	*	*	NA
2.4.4. Drill Misalignment		*	*	*	NA
2.4.5. Sample Volume Measurement	design Review for FM and FS	*	*	*	NA
2.4.6. Induced Loads	(similarity to EQM)	*	*	*	NA
2.4.7 Thermal Contamination		*	*	*	NA
3.1. Unit Reference Frames	design Review	*	*	*	NA
3.2. ICD drawings	Inspection	*	*	*	NA
3.3.1.1 Mounting Position	design Review	*	*	*	NA
3.3.1.2 Fixation Points	design Review + Inspection	*	*	*	NA
3.3.1.3 Drilling Hole	design Review + Inspection	*	*	*	NA
3.3.2.1. Çiva-M I/F – Optical	design Review + Inspection	*	*	*	NA
3.3.2.2. Çiva-M I/F – Mechanical	design Review + Inspection	*	*	*	NA
3.3.3.1 Tapp. Station Mounting	design Review + Inspection	*	*	*	NA
3.3.3.2 MTO Position	design Review + Inspection	*	*	*	NA
3.3.3.3 MTO Electrical Contacts	design Review + Inspection	*	*	*	NA
3.3.3.4. MTO Electrical Specification	design Review + Inspection	*	*	*	NA
3.3.4. High Temp. Oven I/F	design Review + Inspection	*	*	*	NA
3.3.5. Carousel Position Accuracy	Functional Test (section 8.3)	*	*	*	NA
3.4 MU first Eigenfrequency	Resonance Survey Test (section 8.3)	*	*	*	NA
3.5. Aperture Covers	design Review + Inspection	*	*	*	NA
3.6.1 EU - Lander interface	Inspection	*	*	*	NA
3.6.2. EU first eigenfrequence	Test (resonance survey)	*	*	*	NA
3.7.1 Mass	Physical Properties Measurement	*	*	*	NA
3.7.2 CoG	Physical Properties Measurement	*	*	*	NA
3.7.3 MoI	Physical Properties Measurement	*	*	*	NA
4.1.1. Voltages	Functional Test (section 8.3)	*	*	*	NA
4.1.2.1 Secondary Bus Currents	Functional Test (section 8.3)	*	*	*	NA
4.1.2.2. Primary Bus current	Functional Test (section 8.3)	*	*	*	NA
4.1.2.3. Primary Bus Inrush Current	Functional Test (section 8.3)	*	*	*	NA
4.1.3. Power Consumption	Functional Test (section 8.3)	*	*	*	NA
4.2.1. SD2 CDMS I/F	Test	NA	NA	NA	*
4.2.2. CDMS actions and request codes	Test	NA	NA	NA	*
4.2.3 SD2 Specific Commands	Test	NA	NA	NA	*
4.2.4 SD2 telemetry data		NA	NA	NA	*
4.3. Power and Data Budgets	design Review	*	*	*	NA
4.4.1. Connectors	Inspection	*	*	*	NA
4.4.2. Harness	design Review	*	*	*	NA
5.1.1. Temperature Range	TV Test (section 8.3)	*	*	*	NA
5.1.2. Thermal Control Concept	design Review	*	*	*	NA
5.2. Vibrations	Vibration Tests (section 8.3)	*	*	*	NA

Requirement	verification method	EQM	FM	FS	SW
5.3. Radiation	design Review	*	*	*	NA
5.4.1 AIV Environment	Inspection	*	*	*	NA
5.4.2 Unprotected Environment	design Review	*	*	*	NA
5.5. EMC	EMC Tests (section 8.3)	*	*	*	NA
6. Life Time	design Review	NA	*	*	NA
7.1. Cleanliness	Inspection	NA	*	*	NA
7.2. Components and Materials	design Review	NA	*	*	NA

Table 8.2-1 Verification Plan

8.3 TEST DEFINITIONS

8.3.1 Sampling Tests

This test shall be performed with Mechanical Unit EQM in dedicated environment (Nitrogen purging) and during TV test.

The test shall be performed with representative soil materials.

8.3.2 Functional Tests

Functional Tests shall be carried-out to verify that SD2 hardware and SW performs its functions as foreseen by design documentation (including redundancy check).

Formal Functional Test of the Mechanical Unit shall be performed after full characterization of the Electronic Unit in order to assure that the working points of the Mechanical Unit actuators can be reached.

The test with Mechanical Unit (EQM, FM and FS models) will be performed in dedicated environment (Nitrogene purging) and during TV test.

Limited Functional Check-out shall be foreseen to allow equipment health-check prior/after major AIT steps (transportation, environmental tests, etc.).

The Voltage/Current/Power requirements (sections 4.1.1, 4.1.2 and 4.1.3) will be verified during Electronic Unit tests.

8.3.3 Vibration Tests

Vibration Tests will be performed in the following sequence:

1. Unit functional checkout
2. Resonance Survey
3. Sine Vibrations
4. Resonance Survey
5. Random Vibrations
6. Resonance Survey
7. Unit functional checkout

Resonance survey will be performed with the following parameters:
- frequency 5 - 2000 Hz,
- acceleration 0.2 g,
- sweep rate 2 oct/min.

Test levels for Sine and Random Vibrations are defined in section 5.2 (qualification levels for EQM and acceptance levels for FM and FS).

The following approach will be applied for Mechanical Unit EQM qualification tests:

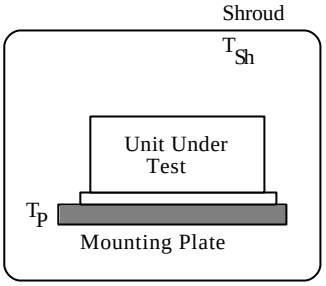
- The unit will be vibrated using, for rigid support flange, qualification levels specified for SD2 base.
- During the test accelerations at unit top will be measured.
- If the accelerations measured at unit top are lower than ones specified for tests, then two options will be possible:
  - if the measured accelerations do not differ too much from specified values then the test will be repeated with vibrations profile at unit base proportionally increased to ensure specified accelerations at unit top;
  - otherwise the tests will be repeated using as control accelerometers the ones placed at unit top.
  The option to follow will be decided during testing.
  In either case, accelerations at unit base flange will always be checked so that they will never exceed specified level for more than 10%; this could be achieved by notching the commanded input profile at unit top.

Acceptance tests of Mechanical Unit FM and FS will be performed following the option selected during EQM testing.

8.3.4 TV Tests

TV test will be performed on Mechanical and Electronic units separately.

Test configuration (in vacuum chamber) is shown in the figure:



TV test temperature profile T_{tv} shall be applied by controlling temperatures of the shroud and unit mounting plate ($T_{sh} = T_p = T_{tv}$).

TV test shall be performed following the temperature/pressure profile shown in AD2 section 8.5 with the following changes:

1. in temperature profile (figure 8-1 in AD2) the Switch-on temperature will be taken equal to Operating temperature TSO = TO;

Temperature limits for Electronic Unit TV tests are defined in table 8.3.4-1.

		FM and FS models	EQM model
Electronic Unit	TNO-MAX	+70 °C	+80 °C
	TO-MAX	+50 °C	+ 60 °C
	TO-MIN	-40 °C	-50 °C
	TNO-MIN	-55 °C	-65 °C

Table 8.3.4-1: Electronic Unit TV test temperatures.

Temperature limits for Mechanical Unit TV tests are defined in table 8.3.4-2.

		FM and FS models	EQM model
Mechanical Unit	TNO-MAX	0 °C	10 °C
	TO-MAX	-50 °C	-40 °C
	TO-MIN	-140 °C	-150 °C
	TNO-MIN	-150 °C	-160 °C

Table 8.3.4-2: Mechanical Unit TV test temperatures.

Functional Test of units shall be performed during TV tests (shown in figure 8-1 in AD2).

8.3.5 EMC

Test set-up for EMC tests shall be in accordance with AD2.

Test levels are specified in section 5.5 (reference to AD2).

Conducted Emissions and Susceptibility tests will be performed on Electronic Unit (connected to Mechanical Unit or Simulator).

Radiated Emission Tests will be performed on EM at Lander Level.

Test case #1 defined in Power Consumption section 4.1.3 shall be used for emission tests.

8.4 REQUIREMENTS TRACEBILITY

This section trace implementation of the requirement into lower level specifications or documents that ensure its verification at subsystem level.

The lower level specifications of the SD2 subsystem are:

1. Mechanical Unit Specification SD2A-AB-TS-025 [MUS]
2. Electronic Unit Specification SHARK-AB-TS-006 [EUS]
3. Harness Specification SHARK-AB-TS-084 [HS]
4. SW User Requirements Document SHARK URD-TS-067 [URD]

Requirement	Traced to the following Lower level specifications:	Verification at integrated (S/S) level: Is it necessary?: Y / N
2.1. SD2 Subsystem Functional Requirements:		
2.1-1 Carousel Rotation	MUS 3.2.4; EUS: 2.3.1.4 2.3.3.2; URD: 3.1.2.2.1-04 3.1.2.2.1-07 3.1.2.2.2-04	**Y** (MU, EU, SW)
2.1-2 Oven to Port	URD 3.1.2.2.2-05	**N**(*)
2.1-3 Translation positioning	MUS 3.1.1 3.2.3; EUS 2.3.2.1 2.3.3.1; URD 3.1.2.2.1-07 3.1.2.2.2-06	**Y** (MU, EU, SW)
2.1-4 Drill rotation	MUS 3.1.1 3.2.1 EUS 2.3.1.1 URD 3.1.2.2.1-06 3.1.2.2.2-07	**Y** (MU, EU, SW)
2.1-5 Rotation+Translation	MUS 3.1.1.1 3.1.1.2 3.2.1 3.2.3 EUS 2.3.1.1 2.3.2.1 2.5.2-1 URD 3.1.2-01	**Y** (MU, EU, SW)
2.1-6 Move/Measure VC position	MUS 3.1.3 3.2.5; EUS 2.3.3.3 2.3.3.4 2.3.3.5 URD 3.1.2.2.1-15 3.1.2.2.2-13 3.1.2.2.2-14 3.1.2.2.2-15	**Y** (MU, EU, SW)
2.1-7 Release/Arm Smplg Tube	MUS 3.1.1 3.2.2 EUS 2.3.2.3 URD 3.1.2.2.2-24	**Y** (MU, EU, SW)

Requirement	Traced to the following Lower level specifications:	Verification at integrated (S/S) level: Is it necessary?: Y / N
2.1-8 TM acq./dumping	URD 3.1.2.2.3-07 3.1.2.2.3-08 3.1.2.2.3-09 3.1.2.2.3-10 3.1.2.2.3-11 3.1.2.2.3-12	**N**(*)
2.1-9 Em.stop/halt command	URD 3.1.2.2.1-05 3.1.2.2.2-21 3.1.2.2.2-22 3.2.1-05	**N**(*)
2.1-10 Em. stop mode	URD 3.1.2.2.1-14.1	**N**(*)
2.1-11 El. power save mode	EUS 2.3.1.3 2.3.2.2 2.3.3.6 URD 3.1.2.2.2-03 3.1.2.2.2-04 3.1.2.2.2-06 3.1.2.2.2-07 3.1.2.2.2-08 3.1.2.2.2-13 3.1.2.2.2-14 3.1.2.2.2-24 3.1.2.2.2-33 3.1.2.2.2-34	**N**(*)
2.1-12 State after power on	EUS 2.5.2-0	**N**(*)
2.1-13 Translation redundancy	MUS 3.2.3 EUS 2.3.2.1 URD 3.1.6-03	**Y** (MU, EU, SW)
2.1-14 Redundancy check command	URD 3.1.2.2.2-34	**N**(*)
2.1-15 MTOs	MUS 3.2.3	**N**(*)
2.1.-16 Scientific Interfaces	MUS 3.5 3.5.2 3.5.3	**N**(*)
2.2. SD2 Subsystem Checks		
2.2-1 Internal Checks	URD 3.1.2.2.1-01 3.1.2.2.1-02 3.1.2.2.1-03	**N**(**)
2.2-2 External Checks	URD 3.1.2.2.1-18 3.1.2.2.1-19	**N**(***)
2.2-3 Periodic Check	URD 3.1.5-05 3.1.5-10 3.1.5-11	**N**(*)
2.3. SD2 Subsystem Automatic Recovery Actions		
2.3-1 Failure notification	MUS 3.2 (Necessity of a speed sensor) URD 3.1.2.2.1-11 3.1.2.2.1-20 3.1.6-01 3.1.6-05 3.1.6-06	**N**(*)
2.3-2 Translation Recovery Procedure	URD 3.1.6-03	**N**(*)
2.3-3 Other Recovery Procedures	URD 3.1.6-02 3.1.6-07	**N**(*)
2.3-4 Enable/Disable Possibility	URD 3.1.2.2.2-23 3.1.6-09	**N**(*)

Requirement	Traced to the following Lower level specifications:	Verification at integrated (S/S) level: Is it necessary?: Y / N
2.3-5 Recovery Disabled Procedure	URD 3.1.2.2.2-23 3.1.6-08	**N**(*)
2.3.6 Recovery Values Definition	S/S	**Y** (MU, EU, SW)
2.4.1. Comet Soil Characteristics	MUS 3.1.1.1.2	**N**(*)
2.4.2. Sample Quantity	MUS 3.1.1.1.3 3.1.2.1.2	**N**(*)
2.4.3.1 Maximum Sampling Depth	MUS 3.4.1	**N**(*)
2.4.3.2 Depth Selection	MUS 3.2.3 URD 3.1.2.2.2-06	**Y** (MU, SW)
2.4.4. Drill Misalignment	MUS 3.1.1.1.4	**N**(*)
2.4.5. Sample Volume Measurement	MUS 3.1.3.1 EUS 2.3.3.3 2.3.3.4 URD 3.1.2.2.2-15	**Y** (MU, EU, SW)
2.4.6. Induced Loads	MUS 3.4.2	**N**(*)
2.4.7 Thermal Contamination	S/S	Ad hoc Test, Procedure
3.1. Unit Reference Frames	MUS 3.3.1 EUS 2.4.3	**N**(*)
3.2. ICD drawings	MUS 3.3.1 EUS 2.4.1 2.4.2 2.4.3 2.4.5 2.4.6 2.4.7 2.4.8	**N**(*)
3.3.1.1 Unit envelope	MUS 3.3.6	**N**(*)
3.3.1.2 Fixation Points	MUS 3.4.3	**N**(*)
3.3.1.3 Drilling Hole	MUS 3.4.4	**N**(*)
3.3.2.1. Çiva-M I/F – Optical	MUS 3.5.2.1	**N**(*)
3.3.2.2. Çiva-M I/F – Mechanical	MUS 3.5.2.2	**N**(*)
3.3.3.1 Tapp. Station Mounting	MUS 3.5.3.1	**N**(*)
3.3.3.2 MTO Position	MUS 3.5.1-3	**N**(*)
3.3.3.3 MTO Electrical Contacts	MUS 3.1.2.4.1 3.1.2.4.2	**N**(*)
3.3.3.4. MTO Electrical Specification	MUS 3.1.2.3.1 3.1.2.4.3	**N**(*)
3.3.3.5 MTO Heating Temperature	MUS 3.1.2.3	**N**(*)
3.3.4. High Temp. Oven I/F	MUS 3.5.1-2	**N**(*)
3.3.5. Carousel Position Accuracy	MUS 3.2.4-3, 3.2.4-4, EUS 2.3.3.2 URD 3.1.2.2.1-07	**Y** (MU, EU, SW) (ad hoc calibration procedure)
3.3.6 Actuators Working Points	MUS 3.2 EUS 2.3.1.1 2.3.1.4 2.3.2.1 2.3.2.3 2.3.3.3	**Y** (MU, EU)
3.4 MU first Eigenfrequency	MUS 3.3.2	**N**(*)
3.5. Aperture Covers	MUS 3.3.3	**N**(*)
3.6.1 EU - Lander interface	EUS 2.4.2 2.4.3 2.4.5 2.4.8	**N**(*)

Requirement	Traced to the following Lower level specifications:	Verification at integrated (S/S) level: Is it necessary?: Y / N
3.6.2. EU first eigenfrequence	EUS 2.4.4	**N**(*)
3.7.1 Mass	MUS 3.3.4.1 EUS 2.4.1 HRN 2.3.1-6 2.3.2.-5	**N**(*)
3.7.2 CoG	MUS 3.3.4.2 EUS 2.4.1	**N**(*)
3.7.3 MoI	MUS 3.3.4.3 EUS 2.4.1	**N**(*)
4.1.1. Voltages	EUS 2.5.1.1	**N**(*)
4.1.2.1 Secondary Bus Currents	EUS 2.5.1.2	**N**(*)
4.1.2.2. Primary Bus current	EUS 2.5.1.3 2.5.2	**N**(*)
4.1.2.3. DELETED		
4.1.3. Power Consumption	S/S EUS 2.5.2	**Y** (MUS, EUS)
4.1.4 Power Lines Insulation	MUS 3.6.2 EUS 2.5.3	**N**(*)
4.2 Data and Command Interfaces	No requirement	
4.2.1. SD2 CDMS I/F	EUS 3.1.2.1-1 URD 3.1.2.1-24 3.2.4-01	**Y**(EU, SW) Proc: SD2-SD-TS-007
4.2.2. CDMS actions and request codes		
4.2.2-1	URD 3.1.2-01 3.1.2.1-02 3.1.2.1-05 3.1.2.1-08 3.1.2.1-10 3.1.2.1-11 3.1.2.1-12 3.1.2.1-14 3.1.2.1-17 3.1.2.1-18 3.1.2.1-19 3.1.2.1-26 3.1.2.1-28 3.1.2.1-30 3.1.2.1-31 3.1.2.1-33 3.1.2.2.1-16 3.1.2.2.1-17 3.1.3-01 3.1.3-02	**N**(*)
4.2.2-2	URD 3.1.2.1-03 3.1.2.1-04 3.1.2.1-06 3.1.2.1-09 3.1.2.1-23 3.1.2.1-35 3.1.2.1-37	**N**(*)
4.2.2-3	URD 3.1.2.1-34	**N**(*)
4.2.3 SD2 Specific Commands		
4.2.3-1 DELETED		

Requirement	Traced to the following Lower level specifications:		Verification at integrated (S/S) level: Is it necessary?: Y / N
4.2.3-2	URD	3.1.2-01 3.1.2.2.1-10 3.1.2.2.1-12 3.1.2.2.1-13 3.1.2.2.1-14.1 3.1.2.2.1-14.2 3.1.2.2.1-14.3 3.1.2.2.1-14.4 3.1.2.2.1-14.5 3.1.2.2.2-25 3.1.2.2.2-26 3.1.2.2.2-27 3.1.2.2.2-28 3.1.2.2.2-29 3.1.2.2.2-30 3.1.2.2.2-31 3.1.2.2.2-32 3.1.2.2.2-33 3.1.2.2.2-34	N(*)
4.2.3-3	URD	3.1.2.2.2-01 3.1.2.2.2-02 3.1.2.2.2-03 3.1.2.2.2-04 3.1.2.2.2-05 3.1.2.2.2-06 3.1.2.2.2-07 3.1.2.2.2-08 3.1.2.2.2-09 3.1.2.2.2-13 3.1.2.2.2-14 3.1.2.2.2-15 3.1.2.2.2-21 3.1.2.2.2-22 3.1.2.2.2-24	N(*)
4.2.3-4	URD	3.1.2-02	N(*)
4.2.3-5	URD	3.1.2-04	N(*)
4.2.3-6	URD	3.1.2.1-36 3.1.2.1-38 3.1.5-12	N(*)
4.2.3-7	URD	3.1.2.2.2-23 3.1.6-09	N(*)
4.2.4 SD2 telemetry data			
4.2.4-1	URD	3.1.2-05 3.1.5-01 3.1.5-02 3.1.5-08	N(*)
4.2.4-2	EUS URD	2.5.1.4 3.1.5-01	N(*)
4.2.4-3	URD	3.1.2.1-20	N(*)
4.3. Power and Data Budgets	S/S		Review / Analysis
4.4.1. Connectors	MUS EUS HS	3.6.1 2.5.4 2.2.2	N(*)
4.4.2. Harness	HS	1.2	N(*)
5.1.1. Temperature Range	MUS EUS	3.7.1.1 2.6.3	N(*)

Requirement	Traced to the following Lower level specifications:	Verification at integrated (S/S) level: Is it necessary?: Y / N
5.1.2. Thermal Control Concept	S/S	Review
5.2. Vibrations	MUS 3.7.2 EUS 2.6.5	**N**(*)
5.3. Radiation	MUS 3.7.3 EUS 2.6.4 HRN 2.4.2	**N**(*)
5.4.1 AIV Environment	MUS 3.7.4.1 EUS 2.6.2	**N**(*)
5.4.2 Unprotected Environment	MUS 3.7.4.2 EUS 2.6.1 HS 2.5.3	**N**(*)
5.5.1…5.5.4 EMC	EUS 2.6.6.	**N**(*) –see also para. 8.3.5-
5.5.5 Bonding	MUS 3.6.3 EUS 2.5.5	**N**(*)
5.5.6 Grounding Concept	S/S	Review
6. Life Time	MUS 3.8 EUS 2.7.3 HRN 2.5.2	N(*)
7.1. Cleanliness	MUS 3.9.2 EUS 2.7.2 HS 2.5.4	N(*)
7.2. Components and Materials	MUS 3.9.3 EUS 2.7.1 HRN 2.5.1	N(*)
8. Design Verification	MUS 4 EUS 4 HS 4	N(*)
9. Ground Support Equipment	MUS 5 EUS 2.8 URD 3.2.5-1	Review

(*) Verification of the lower level specification is feasible with suitable Test Equipment / Facility

(**) Verification at SW level is sufficient since S/S requirement 2.1-1 is also verified at integrated S/S level.

(***) It is assumed that COSAC, PTOLEMY and Lander fills correctly Backup RAM contents.

9. GROUND SUPPORT EQUIPMENT

The GSE defined herein is split into groups based on its main purpose:
- EGSE: support equipment for Electronic Unit;
- MGSE: support equipment for Mechanical Unit;
- SGSE: support equipment for SW development.

9.1 EGSE

1. CDMS Simulator:
   a PC (including SW) with an extension CDMS simulator unit/board;
2. Test Support SW:
   a SW for Electronic Unit to allow check-out of external electrical interfaces and functionality of the unit;
3. Laboratory Harness:
   a set of cables for ground testing, including cables to allow environmental testing while intermediate connections are needed (TV chamber, EMC, etc.);
   it will provide access to electrical lines to monitor electrical signals;
4. Mechanics simulator: set of motors and sensors, electro-coil, electrical test points to be used for testing of the electronic unit;

9.2 MGSE

1. Soil Samples:
   materials with specified characteristics to be used at functional tests with sampling;
2. Sample Positioning Mechanism:
   a motorised mechanical support to accommodate the sample container during Sampling Test (with Mechanical Unit EQM). It will allow changing type of samples during testing in TV chamber.
3. Mechanical Unit Vibration Adapter:
   the adapter for vibration facilities.
4. Oven GSE:
   jigs and tools to allow integration of the ovens (MTO and HTO) to the Mechanical Unit;
5. Lightweight Support:
   it will allow accommodation of the Mechanical Unit for functional and T/V testing. The structure has to be lightweight to keep its mass minimum and, consequently, to keep to the minimum the time necessary to reach thermal stabilisation before testing;
6. Drilling Test Equipment:
   it will be used for Integrated Drill/Sample Tool testing; will contain mechanism for dummy ovens positioning, container for Soil Samples and video cameras to allow visual observation of sample discharge procedure;
7. Nitrogen Purging Station:
   Glove-Box and Nitrogen Purging Equipment to allow testing of the Mechanical Unit.

9.3 SGSE

1. SGSE-1 - the Electronic Unit model equivalent to FM in electrical schematics but with ComDPU Laboratory Model;

10. GROUND OPERATIONS

This section provides definition of on-ground activities with SD2 equipment during/after delivery to Lander Level.

The following tests are foreseen with SD2 at Lander Level:

- Incoming Inspection of the Electronic Unit
- Incoming Inspection of the Mechanical Unit
- SD2 Limited Functional Test

During unit Incoming Inspections stand-alone functional tests will be performed.

Mechanical Unit Stand-alone test Set-up is shown in the figure 8.3-1.

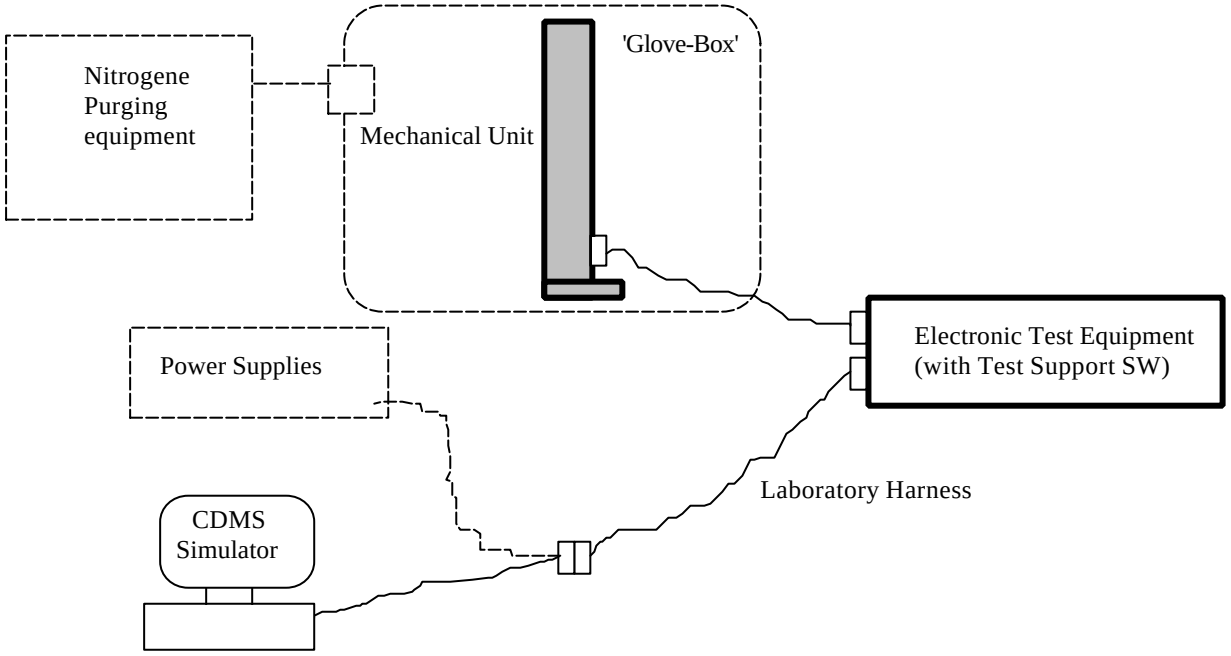


Figure 8.3.-1 Mechanica Unit Stand-alone Test Set-up

Electronic Unit Stand-alone test Set-up is shown in the figure 8.3-2.

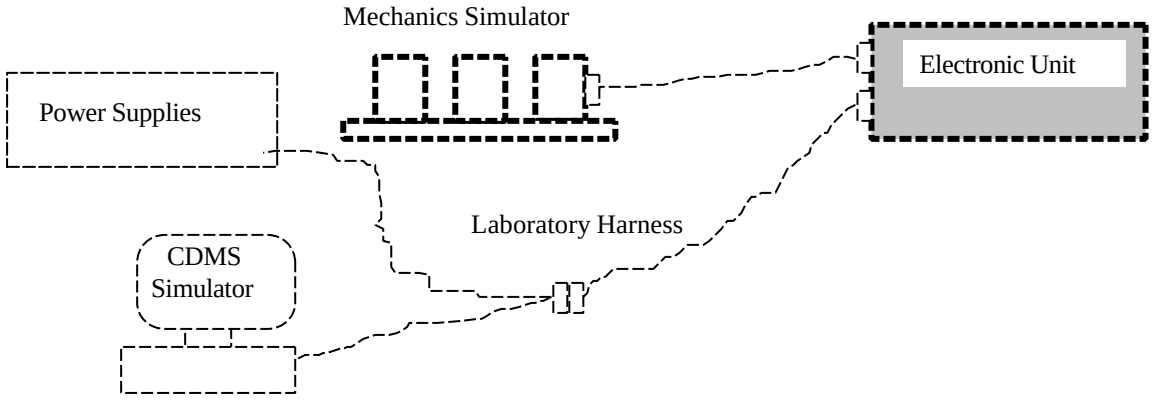


Figure 8.3-2 Electronic Unit Stand-alone Test Set-up

SD2 Limited Functional Test Set-up is shown in the figure 8.3-3.

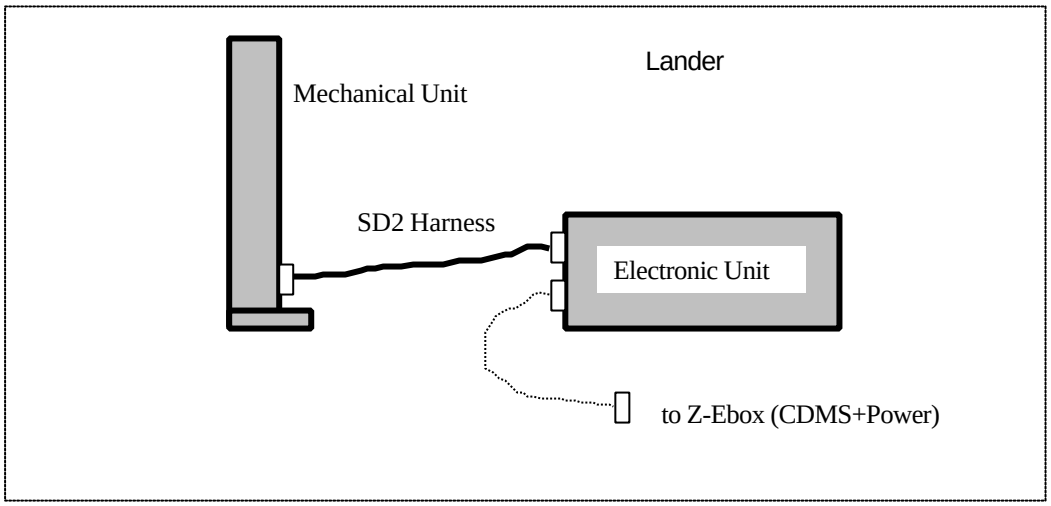


Figure 8.3-3 SD2 Limited Functional Test Set-up

The following mechanisms motion will be allowed during SD2 Limited Functional Test (in standard AIV environment):

- carousel rotation: ± 2 degrees;
- drill rotation: 1 minute with speed defined for test case #1 in section 3.1.3.
- drill translation: ± 1 mm;
- sampling tube arm-release cycles: 1
(arming of the tube will be done manually).

In total no more than 2 (TBC) cycles of SD2 Limited Functional Test will be allowed.